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SPECIFICATION

AIR-CONDITIONING GARMENT

TECHNICAL FIELD

The present invention relates to an air-conditioning garment used as an auxiliary device which effectively exercises a body cooling function using vaporization heat of sweat that humans originally have.

BACKGROUND ART

In a heated term like summer, means for keeping out the heat which is currently most extensively used is an air conditioner. This directly cools air in a room, and hence it is very effective in keeping out the heat.

However, the air conditioner is an expensive apparatus, and its penetration rate for households has been increased, but it is yet to be set in each room in a family unit. Further, since the air conditioner consumes a large quantity of electric power, spread of the air conditioner increases a power consumption in the whole society. Furthermore, under existing circumstances where a fossil fuel accounts for a large percentage of electric power generation, spread of the air conditioner leads to an ironic effect of global warming. Moreover, since the air conditioner cools air itself in a room, there can be considered a problem that excessive cooling ruins health.

In order to solve the above-described problems, the present inventor has originated a cooling garment which consumes a small quantity of power even in a heated term and with which a user can comfortably spend such a season (PCT/JP01/01360). This cooling garment includes a circulation path through which air is circulated between the garment and an undergarment or a body, and air sending means integrally provided with the garment. In this cooling garment, outside air is taken into the circulation path to be circulated by the air sending means, whereby a body is cooled based on a temperature difference between a body temperature and a temperature of the outside air. A wearer can keep out the heat by just wearing this cooling garment. Therefore, if this cooling garment is widely spread, the air conditioner is almost no longer necessary, thereby greatly contributing to global environment protection.

Meanwhile, in general, a cooling effect obtained by wearing a cooling garment differs depending on an individual difference or an intended use of a wearer. For example, when a heavy person wears a cooling garment, the sufficient cooling effect may not be obtained unless a large flow quantity of air is caused to flow through a circulation path as compared with a case where a person having a small weight wears the cooling garment. Further, when a wearer is involved in a heavy duty, the sufficient cooling effect cannot be obtained unless a large flow

quantity of air is caused to flow through the circulation path as compared with a case where he/she is involved in a light duty. In a conventional cooling garment, this point is not taken into consideration, and air is just caused to flow between the garment and an undergarment or a body. Furthermore, the conventional cooling garment does not include a concept that a later-described physiological cooler using sweat as a coolant is exploited. As will be described later, air having a fixed flow quantity or above which is determined based on conditions such as an ambient temperature, contents of a work performed by a wearer, a weight of the wearer and others must be circulated in order to exploit the physiological cooler. In the conventional cooling garment on the premise of circulating just a small amount of air without considering these conditions, the intended sufficient cooling effect cannot be obtained.

DISCLOSURE OF THE INVENTION

In view of the above-described problems, it is an object of the present invention to provide an air-conditioning garment capable of expanding a range in which a physiological cooler function originally included in a human body is effectively exercised, with a small power consumption in accordance with an individual difference or an intended use of a wearer.

In order to achieve this object, according to the present invention defined in claim 1, there is provided an

air-conditioning garment comprising: air guiding means for covering a predetermined part of a body and guiding air along a surface of the body or an undergarment in a space between itself and the body or the undergarment; one or a plurality of air circulating portions which take air flowing in the space between the air guiding means and the body or the undergarment to the outside or take outside air into the space between the air guiding means and the body or the undergarment; one or a plurality of air sending means for forcibly generating a flow of air in the space between the air guiding means and the body or the undergarment; and power supplying means for supplying power to the air sending means, wherein the air sending means generates air flowing with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer, and the air sending means circulates air in the space between the air guiding means and the body or the undergarment to facilitate vaporization of sweat generated from the body and expand a range in which a physiological cooler function originally included in a human body is effectively exercised.

The air-conditioning garment according to the present invention defined in claim 1 uses, as the air sending means, one which can generate air flowing with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer. Therefore, since this air-conditioning garment can rapidly vaporize sweat generated from the body, the range in which

the physiological cooler function originally included in a human body is effectively exercised can be expanded, thereby demonstrating the sufficient cooling effect.

In order to achieve the above-described object, according to the present invention defined in claim 2, there is provided an air-conditioning garment comprising: air guiding means for covering a predetermined part of a body and guiding air along a surface of the body or an undergarment in a space between itself and the body or the undergarment; one or a plurality of air circulating portions which take air flowing in the space between the air guiding means and the body or the undergarment to the outside or take outside air into the space between the air guiding means and the body or the undergarment; one or a plurality of air sending means for forcibly generating a flow of air in the space between the air guiding means and the body or the undergarment; and power supplying means for supplying power to the air sending means, wherein the air sending means circulates air in the space between the air guiding means and the body or the undergarment to facilitate vaporization of sweat generated from the body and expand a range in which a physiological cooler function originally included in a human body is effectively exercised, and the air-conditioning garment has such an air-conditioning capability as vaporization heat drawn from the periphery by the sweat generated from the body is at least 340 calories/hour per kg of a weight of a wearer when

outside air has a temperature of 33 °C and humidity of 50 %.

Here, in a case where outside air has a temperature of 33 °C and humidity of 50 %, when the air sending means utilizes this outside air to generate air which flows with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer, vaporization heat drawn from the periphery by sweat generated from the body is at least 340 calories/hour per kg of the weight of the wearer. Therefore, the air-conditioning garment according to the present invention defined in claim 2 demonstrates the same function/effect as that of the invention defined in claim 1.

In order to achieve the above-described object, according to the present invention defined in claim 3, there is provided an air-conditioning garment comprising: air guiding means for covering a predetermined part of a body and guiding air along a surface of the body or an undergarment in a space between itself and the body or the undergarment; one or a plurality of air circulating portions which take air flowing in the space between the air guiding means and the body or the undergarment to the outside; one or a plurality of air sending means for taking outside air into the space between the air guiding means and the body or the undergarment and forcibly generating a flow of air in the space between the air guiding means and the body or the undergarment; and power supplying means for supplying power to the air sending means, wherein the air sending means generates air flowing with a flow quantity of

at least 2 liters/second, and the air sending means circulates air in the space between the air guiding means and the body or the undergarment to facilitate vaporization of sweat generated from the body and expand a range in which a physiological cooler function originally included in a human body is effectively exercised.

The air-conditioning garment according to the present invention defined in claim 3 demonstrates the same function/effect as that of the invention defined in claim 1. In particular, in the air-conditioning garment according to the present invention defined in claim 3, since the air sending means sends air with a flow quantity of at least 2 liters/second, a pressure of this air can be used to automatically form a space in which air flows in substantially parallel with the surface of the body or the undergarment between the air guiding means and the body or the undergarment.

In order to achieve the above-described object, according to the present invention defined in claim 4, there is provided an air-conditioning garment comprising: air guiding means for covering a predetermined part of a body and guiding air along a surface of the body or an undergarment in a space between itself and the body or the undergarment; one or a plurality of air circulating portions which take air flowing in the space between the air guiding means and the body or the undergarment to the outside or take outside air into the space between the air

guiding means and the body or the undergarment; at least two air sending means for forcibly generating a flow of air in the space between the air guiding means and the body or the undergarment; and power supplying means for supplying power to the air sending means, wherein the air sending means is attached at a part close to a rib in a lower portion of the air guiding means on a back side and generates air flowing with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer, and the air sending means circulates air in the space between the air guiding means and the body or the undergarment to facilitate vaporization of sweat generated from the body and expand a range in which a physiological cooler function originally included in a human body is effectively exercised.

The air-conditioning garment according to the present invention defined in claim 4 demonstrates the same function/effect as that of the invention defined in claim 1. In particular, in the air-conditioning garment according to the present invention defined in claim 4, since the air sending means is attached at the part close to the rib in the lower portion of the air guiding means on the back side, the air sending means does not become an obstacle even if a wearer leans back in a chair, and the wearer's arm can be prevented from coming into contact with the air sending means during a work. Furthermore, the air sending means cannot be seen when viewed from a front side, thereby

improving the appearance of the air-conditioning garment. Moreover, when the air circulating portion is formed at an upper portion of the air guiding means, air can be circulated in substantially all of the body portion covered with the air guiding means.

In order to achieve the above-described object, according to the present invention defined in claim 5, there is provided an air-conditioning garment comprising: air guiding means for covering a predetermined part of a body and guiding air along a surface of the body or an undergarment in a space between itself and the body or the undergarment; one or a plurality of air circulating portions which take air flowing in the space between the air guiding means and the body or the undergarment to the outside; one or a plurality of air sending means for taking outside air into the space between the air guiding means and the body or the undergarment and forcibly generating a flow of air in the space between the air guiding means and the body or the undergarment; and power supplying means for supplying power to the air sending means, wherein the air sending means is attached at a back portion of the air guiding means and generates air flowing with a flow quantity of at least 10 liters/second, and the air sending means circulates air in the space between the air guiding means and the body or the undergarment to facilitate vaporization of sweat generated from the body and expand a range in which a physiological cooler function originally

included in a human body is effectively exercised.

The air-conditioning garment according to the present invention defined in claim 5 demonstrates the same function/effect as that of the invention defined in claim 1. In particular, in the air-conditioning garment according to the present invention defined in claim 5, the air sending means is attached at the back portion of the air guiding means, and means for generating air flowing with a flow quantity of at least 10 liters/second is used as the air sending means. Therefore, this air-conditioning garment is suitable to be used as a workwear for a standing work, for example.

In order to achieve the above-described object, according to the present invention defined in claim 6, there is provided an air-conditioning garment which is put on under an overgarment, comprising: air guiding means for covering a predetermined part of a body and guiding air along a surface of the body or an undergarment in a space between itself and the body or the undergarment; one or a plurality of air circulating portions which take air flowing in the space between the air guiding means and the body or the undergarment to the outside or take outside air into the space between the air guiding means and the body or the undergarment; one or a plurality of air sending means for forcibly generating a flow of air in the space between the air guiding means and the body or the undergarment; and power supplying means for supplying power

to the air sending means, wherein the air sending means generates air flowing with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer, a maximum static pressure of the air sending means is at least 30 pascals, and a temperature gradient in the vicinity of the surface of the body is increased to cool the body, sweat generated from the body is vaporized and vaporization heat drawn from the periphery by sweat at the time of vaporization is utilized to cool the body when the air sending means circulates air in the space between the air guiding means and the body or the undergarment.

The air-conditioning garment according to the present invention defined in claim 6 demonstrates the same function/effect as that of the invention defined in claim 1. In particular, in the air-conditioning garment according to the present invention defined in claim 6, since means having such air sending pressure characteristics as the maximum static pressure is at least 30 pascals is used as the air sending means, the air sending means can assuredly discharge air flowing in the space between the air guiding means and the body or the undergarment into a space between the air guiding means and an overgarment. Therefore, this air-conditioning garment is suitable to be used as an intermediate garment which is put on between the overgarment and the body or the undergarment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic block diagram of a human body illustrating a principle of a physiological cooler;

FIG. 2 is a view illustrating a relationship between a maximum heat radiation enabled quantity and a temperature/humidity of outside air when a temperature of a body surface is maintained at 33 °C by vaporization heat of sweat under a situation where air having a flow quantity of 10 liters/second is caused to flow in the vicinity of the body surface;

FIG. 3 is a view schematically showing a distribution of a wind speed with respect to a distance from one flat plate when air is caused to flow between two parallel flat plates;

FIG. 4 is a view illustrating an air-conditioning garment which realizes an ideal parallel-to-body airstream;

FIG. 5 is a view illustrating specifications of various kinds of air-conditioning garments;

FIG. 6 is a view illustrating specifications of various kinds of air-conditioning garments;

FIG. 7 is a view illustrating specifications of various kinds of air-conditioning garments;

FIG. 8 is a view illustrating specifications of various kinds of air-conditioning garments;

FIG. 9A is a schematic front view of an air-conditioning garment according to a first embodiment of the present invention, and FIG. 9B is a schematic rear view of the air-conditioning garment;

FIG. 10A is a schematic cross-sectional view of air sending means used in the air-conditioning garment according to the first embodiment, and FIG. 10B is a schematic plan view of an impeller used in the air sending means;

FIG. 11A is a schematic side view of an internal fan guard used in the air sending means, FIG. 11B is a schematic plan view of the internal fan guard used in the air sending means, and FIG. 11C is a schematic plan view of an external fan guard used in the air sending means;

FIG. 12A is a view illustrating a hole portion formed in a clothing material portion, and FIG. 12B is a view illustrating a state where the air sending means is attached to the clothing material portion;

FIG. 13A is a schematic front view of an air-conditioning garment according to a second embodiment of the present invention, and FIG. 13B is a schematic rear view of the air-conditioning garment;

FIG. 14A is a schematic plan view of an integrated belt used in the air-conditioning garment, and FIG. 14B is a view illustrating a state where the integrated belt is attached to a clothing material portion;

FIG. 15A is a schematic plan view of a local spacer used in the air-conditioning garment, FIG. 15B is a schematic side view of the local spacer, and FIG. 15C is a view illustrating a state where the local spacer is attached to the clothing material portion;

FIG. 16A is a schematic front view of an air-conditioning garment according to a third embodiment of the present invention, and FIG. 16B is a schematic rear view of the air-conditioning garment;

FIG. 17A is a schematic front view of an air-conditioning garment according to a fourth embodiment of the present invention, and FIG. 17B is a schematic rear view of the air-conditioning garment;

FIG. 18A is a schematic front view of an air-conditioning garment according to a fifth embodiment of the present invention, and FIG. 18B is a schematic rear view of the air-conditioning garment;

FIG. 19A is a schematic plan view of a part of a pressure-proof spacer used in the air-conditioning garment, and FIG. 19B is a schematic side view of a part of the pressure-proof spacer;

FIG. 20A is a schematic front view of an air-conditioning garment according to a sixth embodiment of the present invention, FIG. 20B is a schematic rear view of the air-conditioning garment, and FIG. 20C is a schematic front view of an undergarment which is put on under the air-conditioning garment;

FIG. 21A is a schematic front view of an air-conditioning garment according to a seventh embodiment of the present invention, and FIG. 21B is a schematic rear view of the air-conditioning garment;

FIG. 22 is a view illustrating air sending means used

in the air-conditioning garment;

FIG. 23A is a schematic front view of an air-conditioning garment according to an eighth embodiment of the present invention, and FIG. 23B is a schematic rear view of the air-conditioning garment;

FIG. 24A is a schematic front view of an air-conditioning garment according to a ninth embodiment of the present invention, and FIG. 24B is a schematic rear view of the air-conditioning garment;

FIG. 25A is a schematic front view of an air-conditioning garment according to a 10th embodiment of the present invention, and FIG. 25B is a schematic rear view of the air-conditioning garment;

FIG. 26A is a schematic front view of an air-conditioning garment according to an 11th embodiment of the present invention, and FIG. 26B is a schematic rear view of the air-conditioning garment;

FIG. 27A is a schematic front view of an air-conditioning garment according to a 12th embodiment of the present invention, and FIG. 27B is a schematic rear view of the air-conditioning garment;

FIG. 28 is a view illustrating air sending means used in the air-conditioning garment;

FIG. 29A is a schematic front view of an air-conditioning garment according to a 13th embodiment of the present invention, FIG. 29B is a schematic rear view of the air-conditioning garment, and FIG. 29C is a view

illustrating lower air leak preventing means used in the air-conditioning garment;

FIG. 30A is a schematic front view of an air-conditioning garment according to a 14th embodiment of the present invention, and FIG. 30B is a schematic rear view of the air-conditioning garment;

FIG. 31 is a schematic block diagram of a circuit portion in the air-conditioning garment;

FIG. 32A is a schematic front view of an air-conditioning garment according to a 15th embodiment of the present invention, and FIG. 32B is a schematic rear view of the air-conditioning garment;

FIG. 33A is a schematic front view of air sending means used in the air-conditioning garment, and FIG. 33B is a schematic side view of the air sending means;

FIG. 34A is a view illustrating a state where the air-conditioning garment is put on, and FIG. 34B is a view illustrating a state of a belt portion when the air-conditioning garment is put on;

FIG. 35A is a schematic front view of an air-conditioning garment according to a 16th embodiment of the present invention, and FIG. 35B is a schematic rear view of the air-conditioning garment;

FIG. 36A is a schematic plan view when an air-conditioning belt used in the air-conditioning garment is seen from a rear surface side, and FIG. 36B is a view illustrating a state where the air-conditioning belt is

fastened;

FIG. 37 is a schematic side view of air sending means used in the air-conditioning garment; and

FIG. 38 is a view schematically showing an air flow path reaching an air circulating portion from air sending means through a space between air guiding means and a body or an undergarment.

BEST MODE FOR CARRYING OUT THE INVENTION

An air-conditioning garment according to the present invention is used as an auxiliary device which effectively exercises a cooling function of a body based on vaporization heat of sweat that humans originally have. This point will be first described in detail.

A human can be considered as a very inefficient working device which takes in foods to perform a life-sustaining act or work and generates heat in accordance with such an act. Since the efficiency is poor, almost all calories taken in are turned to heat. Further, in order to maintain a normal body temperature, radiation of heat having a quantity corresponding to a quantity of work at a given time is required. Specifically, in case of a standard adult, a quantity of radiation of heat from a body is approximately 100 kilocalories/hour at rest and approximately 260 kilocalories/hour during walking (a speed: 5 km/hour). Further, it is said that a quantity of radiation of heat exceeds 1000 kilocalories/hour during a

labor at the maximum level. A human is originally provided with a function of cooling his/her body by perspiration (which will be also referred to as a "physiological cooler" hereinafter) as a function performing this heat radiation, and this physiological cooler has a capability of sufficiently radiating a quantity of heat radiation during a labor at the maximum level. That is, a physiologically required quantity of heat radiation is determined in accordance with a quantity of work, and a quantity of sweat corresponding to this quantity of heat radiation comes out from a human body. Furthermore, when sweat is all vaporized, heat radiation optimum for a situation at a given time of this person is carried out. Of course, a quantity of sweat corresponding to a quantity of heat radiation is not uniquely calculated by a brain. However, when a body temperature acutely increases, a large quantity of sweat keeps coming out from a human body. As a result, when a body temperature is lowered, a quantity of sweat is reduced, and hence the body is not cooled too much.

In light of cooling a body by vaporization of sweat, the sweat is roughly classified into effective perspiration which contributes to cooling and ineffective perspiration which does not contribute to cooling. The sweat can be further finely classified into three types, i.e., rapidly effective perspiration, slowly effective perspiration and ineffective perspiration. The rapidly effective perspiration means sweat which is vaporized simultaneously

with generation from a body. This rapidly effective perspiration is immediately evaporated, and hence the body is rapidly cooled. The slowly effective perspiration means sweat which is generated in a state of a liquid from a body. This slowly effective perspiration is not immediately evaporated, and hence an undergarment becomes wet with sweat. The cooling effect cannot be immediately obtained when the body needs this effect. However, for example, when the wind blows, sweat is belatedly vaporized, thereby cooling the body. Further, ineffective perspiration means sweat dripping from the body. In this case, there is no cooling function of the body based on vaporization. When ineffective perspiration comes out, the body is in a state that the physiological cooler does not effectively function, and a body temperature keeps increasing. Therefore, the body cannot maintain a fixed state.

If the physiological cooler effectively functions, a necessary quantity of sweat corresponding to a change or the like in a work quantity serves as rapidly effective perspiration to cool down the body, and liquid-like sweat does not remain in an undergarment, thereby constantly maintaining the body in a comfortable state. However, when sweat cannot be all vaporized under conditions such as a temperature/humidity, presence/absence of the wind, a work quantity and others, a required quantity of heat radiation cannot be obtained. The body keeps producing wasteful liquid-like sweat (the ineffective perspiration) which is

not vaporized, and not only a human feels discomfort but also he/she is physiologically damaged.

FIG. 1 is a schematic block diagram of a human body illustrating a principle of a physiological cooler. As shown in FIG. 1, it can be considered that a human body is provided with an energy thermogenetic portion which generates heat in accordance with working or the like, a sensor portion which detects a body temperature or the like, a calculation control portion (mainly a brain) which calculates/controls a necessary heat radiation quantity, a water storage portion which stores water (sweat) as a coolant, a sweat gland along which water (sweat) as a coolant is carried to a surface of a body in response to an instruction from the calculation control portion, and a vaporization plate (a skin) having a large area which lightly moistens the entire body with sweat from the sweat gland. Here, the human body has a capability of sufficiently radiating a thermogenetic quantity during a labor at the maximum level mentioned above as a maximum sweat supply capability. As described above, it can be said that the human body is provided with an ideal perfect cooling system.

Meanwhile, if sweat which has come out from the sweat gland just covers the skin as the vaporization plate, the body cannot be cooled. A function as the physiological cooler can be demonstrated by vaporizing sweat. In order to vaporize sweat, later-described air is required.

Furthermore, if there is no flow of air, air on a skin surface immediately reaches a saturated state due to vaporization of sweat, and sweat cannot be vaporized any further. Therefore, in order to continuously vaporize sweat, a flow of air must be produced in the vicinity of the skin. As means for artificially producing such a flow of air on the skin surface, there is an electric fan. However, for example, the electric fan cannot be used out of doors, and hence there are many problems.

On the other hand, the present inventor has studied out a cooling garment as means for producing a flow of air in the vicinity of a surface of a body (PCT/JP01/01360). This cooling garment is provided with a circulation path through which air is circulated between the garment and an undergarment or a body, and air sending means attached to the garment. In this cooling garment, when outside air is taken into the circulation path to be circulated by the air sending means, the body is cooled by using a temperature difference between a body temperature and a temperature of outside air.

The air-conditioning garment according to the present invention is obtained by developing this scheme. That is, in the air-conditioning garment according to the present invention, a flow of air is forcibly produced in a space between a clothing material and a body by air sending means, and a humidity gradient on a surface of a skin corresponding to the vaporization plate is increased by

circulating air along the surface of the body in a space between the clothing material and the body. As a result, sweat supplied in accordance with a heat radiation quantity required by the body is all vaporized as rapidly effective perspiration. The air-conditioning garment is an auxiliary device which allows the physiological cooler originally included in the human body to effectively function.

When the physiological cooler perfectly functions, there is no argument about a fact that the physiological cooler is a perfect and ideal cooler for a human body. A problem is how much the auxiliary device which allows the physiological cooler to perfectly function, i.e., the air-conditioning garment can increase performance of the physiological cooler.

When an outside air temperature is low or a thermogenetic quantity is small, of course, the physiological cooler does not effectively function. Moreover, the human body is not substantially provided with a function which is opposite to the physiological cooler, i.e., a function which suppresses heat radiation from the human body, and a blood flow volume of the body surface is physiologically reduced at the utmost. Therefore, in such a case, a person actually adjusts a garment by himself/herself to adjust his/her body temperature. That is, a person dress in several layers of clothing when feeling cold. On the contrary, when an outside air temperature is high or a thermogenetic quantity is large,

wearing the air-conditioning garment and wrapping a part close to the body surface with a sufficient flow quantity of air allows the physiological cooler to effectively function, and optimum heat radiation is automatically carried out even if a person does not take off his/her garment. When an outside air temperature is low or a thermogenetic quantity is small in this manner, any action, e.g., adjusting a garment or warming himself/herself must be taken. On the contrary, when an outside air temperature is high or a thermogenetic quantity is large, the body can be constantly maintained in an optimum state by wearing the air-conditioning garment.

Therefore, when a range in which the physiological cooler effectively functions is greatly expanded by using the air-conditioning garment according to the present invention, various kinds of problems, e.g., all problems due to hotness, an energy problem due to an air conditioner, an environmental problem, a health problem such as heatstroke disorder can be solved at once.

A description will now be given as to a relationship between a heat radiation quantity and a temperature/humidity of outside air when a temperature of a body surface is maintained at 33 °C by vaporization heat of sweat. FIG. 2 is a view illustrating a relationship between a maximum heat radiation enabled quantity and a temperature/humidity of outside air when a temperature of a body surface is maintained at 33 °C by vaporization heat of

sweat under a situation where air having a flow quantity of 10 liters/second is caused to flow in the vicinity of the body surface. Here, in FIG. 2, a vertical axis represents humidity (%) and a horizontal axis represents a temperature (°C). Further, FIG. 2 shows temperature/humidity conditions when the maximum heat radiation enabled quantity is 0 calorie/hour, 200 kilocalories/hour and 500 kilocalories/hour. As can be understood from FIG. 2, for example, when outside air has a temperature of 35 °C and humidity of 63 %, sufficient supply of sweat enables heat radiation which is 200 kilocalories/hour at the maximum level. Of course, if a flow quantity of air is doubled, the maximum heat radiation enabled quantity is also doubled.

The maximum heat radiation enabled quantity in FIG. 2 is a theoretical value when air has vaporized sweat without waste. For example, when an electric fan is used to cause air to flow to a human body, a very small part of the wind which has blown contributes to vaporization of sweat, and the maximum heat radiation enabled quantity becomes very small with respect to an air sending quantity. Additionally, when the electric fan is used, there is also a serious problem in properties of the airstream due to a usage pattern of the electric fan. That is, since the electric fan is usually arranged to face a human body, the airstream necessarily substantially vertically comes into contact with the human body. Therefore, it is very difficult to optimize an air sending quantity required to

vaporize sweat. If the air sending quantity is too small, sweat cannot be all vaporized. On the other hand, if the air sending quantity is too large, sweat on the skin with which the airstream has come into contact is completely vaporized, but supply of sweat becomes too slow, and a temperature of the skin surface is affected by a temperature of the airstream. For example, when the airstream having a temperature of 40 °C is strongly brought into contact with the skin, a temperature of the skin becomes approximately 40 °C, resulting in an effect which is completely opposite to cooling. Therefore, in order to vaporize sweat without waste, the airstream which is substantially parallel to the body surface (which will be also referred to as a "parallel-to-body airstream" hereinafter) must be caused to flow in the vicinity of the body surface.

This parallel-to-body airstream will now be described. FIG. 3 is a view schematically showing a distribution of a wind speed with respect to a distance from one flat plate when air is caused to flow between two parallel flat plates. As shown in FIG. 3, it is well known that the wind speed becomes zero on a plate surface. Assuming that one plate is a vaporization plate (a skin) and the other plate is a guide plate used to form a parallel-to-body airstream, there is no flow of air on the skin surface and the skin surface does not receive a pressure of the airstream as shown in FIG. 3. Further, since the wind speed is high

between the two plates, a temperature/humidity gradient of the skin surface is greatly increased. Therefore, when a gap between the skin surface and the guide plate is sufficiently small with respect to a length of an airstream path, the parallel-to-body airstream fully contributes to vaporization of sweat.

A consideration will now be made as to a case where the parallel-to-body airstream having a temperature of 35 °C and humidity of 30 % indicated by a point A in FIG. 2 is caused to flow to wrap a large part of the body with the parallel-to-body airstream. Heat radiation of approximately 100 kilocalories/hour is required when an adult having a standard physical size is at rest, and heat radiation of approximately 260 kilocalories/hour is required when he/she is walking at a speed of 5 km/hour. However, it can be understood from FIG. 2 that heat radiation with the above-described quantities can be carried out when air is caused to flow with a flow quantity of 10 liters/second. Since vaporization heat of water (sweat) is 580 calories/cc at an ordinary room temperature, 100 kilocalories/hour is divided by 580 calories/cc. As a result, it can be understood that sweat having a quantity of 172.4 cc/hour is vaporized at the time of rest. Furthermore, it can be likewise understood that, during walking at the speed of 5 km/hour, sweat having a quantity of 448 cc/hour is vaporized. In this manner, even though the parallel-to-body airstream having a fixed quantity is

blown, sweat having a quantity corresponding to a necessary heat radiation quantity comes out, and the sweat is all vaporized, thereby automatically performing optimum heat radiation. On the contrary, sweat having a larger quantity does not come out. That is because a body temperature is lowered when sweat having a quantity larger than that corresponding to a necessary heat radiation quantity is produced and vaporized, and hence such a thing cannot occur as long as a control function mainly realized by a brain is normally operating. Here, a remarkable point is that a heat radiation quantity is consistently determined by a physiological cooler control function even if air having a flow quantity of 10 liters/second is kept flowing. Therefore, the physiological cooler automatically controls a sweating quantity in such a manner that a sweating quantity is reduced when a necessary heat radiation quantity is decreased and a sweating quantity is increased when a necessary heat radiation quantity is increased. A flow quantity of air concerns a range in which the physiological cooler effectively functions. For example, assuming that a necessary heat radiation quantity is 500 kilocalories/hour, as apparent from FIG. 2, when outside air has a temperature of 35 °C and humidity of 30 %, sweat having a quantity corresponding to a heat radiation quantity cannot be all vaporized even if the outside air is caused to flow as a parallel-to-body airstream with a flow quantity of 10 liters/second. In such a case, increasing

the flow quantity of the parallel-to-body airstream can suffice. The parallel-to-body airstream has an advantage in that the airstream does not substantially vertically come into contact with the body as different from an electric fan even if its flow quantity is increased and a range in which the physiological cooler can effectively function can be readily expanded.

Although the physiological cooler is ideal body heat radiating means in all aspects, the physiological cooler does not have sweat vaporizing means alone. The air-conditioning garment according to the present invention compensates this missing means. In other words, the air-conditioning garment is an auxiliary device which has means for generating a parallel-to-body airstream and expands a range in which the physiological cooler effectively functions.

FIG. 4 is a view illustrating the air-conditioning garment which realizes an ideal parallel-to-body airstream. In order to realize an ideal parallel-to-body airstream, as shown in FIG. 4, it is good enough to cover a substantially entire body surface with a guide sheet (air guiding means) which guides the parallel-to-body airstream. Further, a fixed small gap is formed between the guide sheet and the body surface, a flow of air is generated by, e.g., a large fan disposed overhead, and a large quantity of parallel-to-body airstream is caused to flow in a space between the guide sheet and the body surface. However, even though

such an air-conditioning garment as shown in FIG. 4 is ideal in light of heat radiation of a human body and vaporization of sweat, it is not realistic when leading an actual life. Therefore, there has been demanded the realization of a practical air-conditioning garment which cannot exploit 100 % of the physiological cooler function but can sufficiently demonstrate performance.

Conditions required for the air-conditioning garment from a practical standpoint are listed as follows.

1. A ratio of a surface area of a body part which can be wrapped with a parallel-to-body airstream with respect to a surface area of the entire body (an air-conditioning area ratio) is large (the air-conditioning area ratio must be at least 10 %).

2. The air-conditioning garment must have a shape and a weight which do not obstruct work or the like.

3. The air-conditioning garment can send air for a long time by using a small battery so that it can be used outside, and can generate air having a sufficient flow quantity.

4. The air-conditioning garment must be inexpensive.

5. Electrical components can be readily attached/detached at the time of washing.

6. Besides, safety must be of course assured, and a difference in appearance including fashionability from regular garments must be small, and others.

The condition 1, i.e., the air-conditioning area

ratio will now be concretely described. In order for a wearer to be able to feel comfortable by wearing the air-conditioning garment, of course, it is good enough to wrap a large part of a wear's body as much as possible with a parallel-to-body airstream and facilitate heat radiation of a human body and vaporization of sweat in the wrapped part. In reality, there can be considered an air-conditioning garment which wraps a body part except a face, hands and feet with the parallel-to-body airstream. An air-conditioning area ratio of this air-conditioning garment is approximately 85 %. On the other hand, avoiding an increase in a body temperature at a part of the body alone can suffice in some cases depending on intended purposes of wearing the air-conditioning garment. Specifically, there can be considered an air-conditioning garment which wraps an upper body and armpits alone from which sweat is apt to come out with a parallel-to-body airstream. An air-conditioning area ratio of this air-conditioning garment can be calculated as follows. A surface area of an entire body of an average adult is approximately 1.8 m^2. Assuming that a length of the upper body is 15 cm and a chest measurement is 80 cm, a surface area of the upper body is 1200 cm^2. When an area of armpits is added to this value, an entire surface area of the upper body and the armpits is approximately 1400 cm^2. Therefore, the air-conditioning area ratio in this case is approximately 7.8 %. Considering an individual difference of, e.g., a body type

or the like, it is desirable for the air-conditioning area ratio of the air-conditioning garment according to the present invention to be at least 10 %.

Specifically, the air-conditioning garment according to the present invention is provided with: air guiding means for covering a predetermined part of a body and guiding air along a surface of the body in a space between itself and the body; one or a plurality of air circulating portions which take air flowing in the space between the air guiding means and the body to the outside or take outside air into the space between the air guiding means and the body; one or a plurality of air sending means for forcibly generating a flow of air in the space between the air guiding means and the body; and power supplying means for supplying power to the air sending means. Further, when the air sending means circulates air in the space between the air guiding means and the body, sweat which has come out from the body is vaporized, and vaporization heat which is drawn from the periphery by sweat at the time of vaporization is utilized, thereby cooling the body. Incidentally, as the air guiding means, it is desirable to use means having such air permeability as a ratio of a flow quantity of air leaking from the entire air guiding means to the outside with respect to a flow quantity of air which has been taken into the space between the air guiding means and the body is not more than 60 %.

Here, when a flow quantity of air circulated in the

space between the air guiding means and the body is small, a sufficient cooling effect cannot be obtained. Actually, in order to obtain a sufficient cooling effect by wearing the air-conditioning garment, the air sending means must generate air which flows with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer. For example, when an adult having a weight of 60 kg wears the air-conditioning garment, air must be caused to flow with a flow quantity of at least 0.6 liter/second. According to an experiment conducted by the present inventor and others, when a flow quantity of air was set to a flow quantity smaller than the above-described minimum flow quantity, there was a wearer who feels discomfort in an environment where the wind blows to some extent as compared with a case where a regular garment is put on. That is mainly because one having poor air permeability is used as a material of the air guiding means. On the contrary, in case of a sultry environment where no wind blows, all people wearing the air-conditioning garment felt comfortable by causing air to flow with a flow quantity of 0.6 liter/second as compared with a case where a regular garment is put on. Furthermore, when a flow quantity of air was set to the above-described minimum flow quantity, an effect of preventing sweat from remaining in an undergarment for a long time was obtained. Moreover, it was confirmed that, when a flow quantity of air is further increased, the maximum heat radiation enabled quantity can be increased so

that a range in which the physiological cooler effectively functions can be expanded. Incidentally, in a case where outside air has a temperature of 33 °C and humidity of 50 %, when the air sending means utilizes the outside air to generate air which flows with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer, vaporization heat drawn from the periphery by sweat which has come out from the body is at least 340 calories/hour per kg of the weight of the wearer.

In the air-conditioning garment according to the present invention, means for generating air which flows with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer is used as the air sending means. Therefore, when the air sending means circulates air in the space between the air guiding means and the body, vaporization of sweat which has come out from the body is facilitated, thereby expanding a range in which the physiological cooler function originally included in a human body is effectively exercised.

Additionally, the present inventor has studied out various kinds of air-conditioning garments having different shapes, flow quantities of air or the like. As a result, it is possible to realize optimum air-conditioning garments, e.g., an air-conditioning garment emphasizing fashionability, an air-conditioning garment for carrying out an office work without an air conditioner, an air-conditioning garment for preventing labor accidents due to

hotness, an air-conditioning garment used to comfortably perform outdoor works and others in accordance with intended uses, thereby solving all problems concerning hotness.

Incidentally, it has been experimentally confirmed that an uncomfortable feeling of a wearer cannot be greatly improved even if the air-conditioning garment is put on when slowly effective perspiration is involved, i.e., when a heat radiation quantity is not sufficient for a sweating quantity. However, in a case where the air-conditioning garment is put on, a physiological damage can be reduced if a heat radiation quantity is sufficiently large even though there is an uncomfortable feeling due to sweat, as compared with a case where the air-conditioning garment is not put on. Therefore, even if slowly effective perspiration is involved, wearing the air-conditioning garment is beneficial.

When the air-conditioning garment according to the present invention is used, the air-conditioning garment is usually directly put on over a body, but the air-conditioning garment may be put on over an undergarment. Here, the "undergarment" means clothing which is put on under the air-conditioning garment. However, in a case where the undergarment is put on under the air-conditioning garment, attention must be given to a fact that a range in which the physiological cooler effectively functions is reduced if air permeability of the undergarment is poor,

for example. Further, in a case where the undergarment is put on under the air-conditioning garment, the function of the air-conditioning garment is reduced when a parallel-to-body airstream does not flow in the vicinity of a surface of a body due to existence of the undergarment. In order to avoid this phenomenon, it is desirable to use an undergarment which is rather small and fits to a body. Incidentally, in the following description, it is presupposed that an undergarment is not put on, i.e., a parallel-to-body airstream literally flows between the air-conditioning garment and the body when explaining a heat radiation quantity and others.

Best modes for carrying out the present invention will now be described hereinafter with reference to the accompanying drawings.

The present inventor has studied out 16 types of air-conditioning garments in accordance with intended uses of a wearer. FIGS. 5, 6, 7 and 8 are views illustrating specifications of the 16 types of air-conditioning garments. Specifically, contents of the 16 types of air-conditioning garments are, an air-conditioning garment for a light duty, an air-conditioning garment for a medium duty, an air-conditioning garment for work in the rain, an air-conditioning garment for a line operation, an air-conditioning garment for office use, an air-conditioning garment for outdoor, an air-conditioning garment for deodorization, an air-conditioning garment for children, an

air-conditioning garment for a heavy duty, a jumpsuit type air-conditioning garment, an air-conditioning garment for an intermediate garment, an air-conditioning garment for temperature adjustment, a T-shirt type air-conditioning garment, a high-function type air-conditioning garment, an improved air-conditioning garment for office use, and an air-conditioning belt type air-conditioning garment.

Further, in FIGS. 5, 6, 7 and 8, 19 items are listed as specifications of the air-conditioning garments. Specifically, there are respective items of "air-conditioning capability", "flow quantity", "air sending mode", "spacer", "fan attachment surface", "number of fans", "fan position", "fan type", "total effective fan area", "fan diameter", "power supply type", "power consumption", "air-conditioning area ratio", "sleeve", "air guiding means type", "air circulating portion", "opening/closing means", "lower air leak prevention", and "fan attachment/detachment mode".

In a section of "air-conditioning capability" is written an approximate value (W) obtained by reducing a quantity of heat which can be absorbed per hour by reference air circulated in a space between the air guiding means and the body to a power. Here, the "reference air" means air having a temperature of 33 °C and humidity of 50 %. A section of "flow quantity" shows a flow quantity (liter/second) of air circulated between the air guiding means and the body by the air sending means. A section of

"air sending mode" shows a distinction of a direction in which the air sending means sends air, i.e., one of an "intake" mode of taking outside air into the air guiding means by the air sending means and a "discharge" mode of discharging air in the air guiding means to the outside by the air sending means. Furthermore, a section of "spacer" shows whether a spacer is used between the air guiding means and the body and a type of the spacer when the spacer is used.

A section of "fan attachment surface" shows that the air sending means is attached on an inner surface side or an outer surface side of the air guiding means. A section of "number of fans" shows a quantity of air sending means attached to the air-conditioning garment. A section of "fan position" shows an air sending means attachment position. A section of "fan type" shows a type of the air sending means, e.g., a side stream fan or a propeller fan. A section of "total effective fan area" shows a value of an area (cm^2) obtained by summing up areas of opening portions for air intake or discharge in all the air sending means. A section of "fan diameter" shows a diameter (mm) of an impeller or a propeller of the air sending means.

A section of "power supply type" shows a type of power supplying means. A section of "power consumption" shows a value (W) obtained by summing up power consumptions of all the air sending means. A section of "air-conditioning area ratio" shows a ratio (%) of a surface

area of a body part which can be wrapped with air generated by the air sending means with respect to a surface area of the entire body.

A section of "sleeve" shows that the air-conditioning garment is a short-sleeved garment, a long-sleeved garment, a sleeveless garment or the like. A section of "air guiding means type" shows a material of the air guiding means. A section of "air circulating portion" shows contents of the air circulating portion. A section of "opening/closing means" shows contents of means for opening/closing a front side of the air-conditioning garment. A section of "lower air leak prevention" shows contents of means for preventing air from leaking from a lower portion of the air-conditioning garment. Moreover, a section of "fan attachment/detachment mode" shows contents of a mode for attaching/detaching the air sending means with respect to the air guiding means.

Each of the 16 types of air-conditioning garments will be described in detail in each of the following embodiments.

[First Embodiment]

A first embodiment according to the present invention will be first described with reference to the accompanying drawings. FIG. 9A is a schematic front view of an air-conditioning garment according to the first embodiment of the present invention, and FIG. 9B is a schematic rear view of the air-conditioning garment.

As shown in FIG. 9, an air-conditioning garment 1 according to the first embodiment is provided with a clothing material portion 20, opening/closing means 31, lower air leak preventing means 32, three air circulating portions 40, 40 and 40, two air sending means 50 and 50, power supplying means 61, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown), and flow quantity adjusting means (not shown). This air-conditioning garment 1 is used as the most practical garment for a light duty. Here, a main specification of this air-conditioning garment 1 is organized in the table of FIG. 5.

The clothing material portion 20 covers a predetermined part of a body. In the first embodiment, this clothing material portion 20 is used to manufacture a short-sleeved garment for a light duty which covers an upper body. Additionally, in the first embodiment, the clothing material portion 20 also serves to guide air generated by the air sending means 50 along a surface of a body or an undergarment in a space between the clothing material portion 20 and the body or the undergarment. That is, the clothing material portion 20 functions as a garment which covers the body and also as the air guiding means.

In order to use the clothing material portion 20 as the air guiding means, it is desirable to use, as a material of the clothing material portion 20, one which allows a parallel-to-body airstream to smoothly flow and

can prevent air from leaking to the outside as much as possible. One of optimum materials used for this clothing material portion 20 is a fabric made of 100 % of polyester. Here, the polyester cloth has properties that air permeability is very small. The polyester cloth is generally used as a windbreaker or a winter clothing material because of its properties. Further, the polyester cloth also has properties of a modest price, luster, stain resistance, wrinkle resistance and others. On the other hand, the polyester cloth is generally rarely used as a summer clothing material because it has poor air permeability and hardly absorbs sweat. The small air permeability is a necessary condition for the clothing material portion 20 used in the air-conditioning garment 1 to prevent air from leaking. Furthermore, since sweat is immediately vaporized from a skin (rapidly effective perspiration) when the air-conditioning garment 1 is put on, a material which absorbs sweat does not have to be necessarily used as the clothing material portion 20. Therefore, the polyester cloth meets all conditions required for the clothing material portion 20 for the air-conditioning garment 1. In the first embodiment, the polyester cloth is used as a material of the clothing material portion 20 (the air guiding means).

It is to be noted that, as a material of the clothing material portion 20 for the air-conditioning garment 1, any material can be used as long as air does not substantially

permeate it. For example, it is possible to use a fabric made of plastic fiber like a nylon cloth or a high-density cloth as well as a polyester cloth. Of course, natural fiber such as cotton or mixed fiber of these materials can be used depending on intended uses.

Furthermore, as a material of the clothing material portion 20, a mixed material containing 80 % or more of polyester may be used. The mixed material containing 80 % or more of polyester is used because the advantage of the above-described characteristics of polyester cannot be taken if a percentage of polyester contained in the material is smaller than 80 %.

The opening/closing means 31 is provided in a front portion of the clothing material portion 20. This opening/clothing means 31 functions to open/close the front portion of the air-conditioning garment 1 when it is put on. Moreover, as the opening/closing means 31, it is necessary to use one which can prevent air from leaking from the front portion to the outside when the front portion of the clothing material portion 20 is closed. In the first embodiment, a fastener is used as the opening/closing means 31. The fastener can be readily opened/closed, and air hardly leaks from the fastener portion to the outside when the fastener is closed.

Additionally, the lower air leak preventing means 32 is provided at a hem portion of the clothing material portion 20. This lower air leak preventing means 32

prevents air from leaking from the hem portion to the outside by bringing a lower portion (the hem portion) of the clothing material portion 20 into close contact with the body, the undergarment or a garment. In the first embodiment, as the lower air leak preventing means 32, an elastic material, e.g., a rubber belt used in a winter zip-up jacket or the like is employed. This rubber belt is stitched into the hem portion of the clothing material portion 20. Therefore, the hem portion is brought into close contact with a garment such as pants or the like so that air does not leak to the outside from the hem portion. It is to be noted that a string, a belt or the like as well as the rubber belt can be used as the lower air leak preventing means 32. When a string is used as the lower air leak preventing means 32, this string is attached to the hem portion of the clothing material portion 20 in such a manner that the string can be moved along the hem portion. Further, when the hem portion of the clothing material portion 20 is tightened by using this string, the hem portion is appressed against pants or the like.

The air circulating portion 40 is utilized as an air outflow portion from which air flowing in the space between the clothing material portion 20 and the body or the undergarment is taken to the outside or an air inflow portion from which outside air is taken into the space between the clothing material portion 20 and the body or the undergarment. Whether the air circulating portion 40

is utilized as the air outflow portion or the air inflow portion is determined by an air sending mode of the air sending means 50. That is, when the air sending means 50 operates to take outside air into the clothing material portion 20, the air circulating portion 40 is utilized as the air outflow portion. On the other hand, when the air sending means 50 operates to discharge air in the clothing material portion 20 to the outside, the air circulating portion 40 is utilized as the air inflow portion. In the first embodiment, the air circulating portion 40 is utilized as the air outflow portion.

Furthermore, in the first embodiment, the three air circulating portions 40, 40 and 40 are provided to the air-conditioning garment 1. Specifically, considering a function as a garment, opening portions formed at predetermined end portions of the clothing material portion 20, i.e., an opening portion at a part around a neck and opening portions at left and right cuff parts are the air circulating portions 40, 40 and 40. When the air-conditioning garment 1 is put on and the fastener is closed, except the air sending means 50 and the air circulating portions 40, 40 and 40, there is no part from which air in the clothing material portion 20 flows to the outside. Incidentally, the opening portion at the part around the neck and the opening portions at the left and right cuff parts will be also referred to "upper opening portions" hereinafter.

Hole portions 21 and 21 are formed on both left and right sides close to ribs at a lower part of the clothing material portion 20 on the back side (see FIG. 12A). The air sending means 50 is attached at positions of the clothing material portion 20 corresponding to the respective hole portions 21 from the inner surface side of the clothing material portion 20. The air sending means 50 forcibly generates a flow of air in a space between the clothing material portion 20 and the body or the undergarment. The two air sending means 50 and 50 rotate in a direction of taking outside air into the clothing material portion 20. That is, as an air sending mode of the air sending means 50 and 50, an intake mode is adopted. When electric power is supplied to the air sending means 50 and 50, the air sending means 50 and 50 take outside air into the clothing material portion 20, and the intake air is circulated as a parallel-to-body airstream in the space between the clothing material portion 20 and the body or the undergarment due to existence of the clothing material portion 20. Furthermore, when the parallel-to-body airstream reaches the air circulating portions 40, 40 and 40, it is discharged to the outside.

Here, attachment positions of the air sending means 50 and 50, i.e., positions which are close to the ribs and correspond to the lower part of the clothing material portion 20 on the back side will be referred to as "standard positions". The standard positions are the most

preferable positions as attachment positions of the air sending means 50 and 50. When the air sending means 50 and 50 are attached at the standard positions, the air sending means 50 and 50 do not become obstacles even if a wearer leans back in a chair. Moreover, arms do not come into contact with the air sending means 50 and 50 during a work. Additionally, as seen from a front side, the air sending means 50 and 50 are hidden, and the appearance of the air-conditioning garment 1 is excellent. Further, since the standard positions exist in the lower part of the clothing material portion 20, the parallel-to-body airstream can be circulated in the substantially entire body part which is covered with the clothing material portion 20 when the air circulating portions 40, 40 and 40 are formed in the upper part of the clothing material portion 20. That is, the standard position is a position which can relatively increase a ratio of a surface area of the body part wrapped with the parallel-to-body airstream with respect to a surface area of the entire body (an air-conditioning area ratio). It is to be noted that the air-conditioning area ratio is approximately 35 % in the air-conditioning garment 1 according to the first embodiment.

The air sending means 50 will now be described. FIG. 10A is a schematic cross-sectional view of the air sending means 50 used in the air-conditioning garment 1 according to the first embodiment, and FIG. 10B is a schematic plan view of an impeller used in the air sending means 50. FIG.

11A is a schematic side view of an internal fan guard used in the air sending means 50, FIG. 11B is a schematic plan view of the internal fan guard used in the air sending means 50, and FIG. 11C is a schematic plan view of an external fan guard used in the air sending means 50. Further, FIG. 12A is a view illustrating a hole portion 21 formed in the clothing material portion 20, and FIG. 12B is a view illustrating a state where the air sending means 50 is attached to the clothing material portion 20.

As shown in FIG. 10, the air sending means 50 is provided with a motor 51, an impeller 52, an internal fan guard 53, an external fan guard 54 and a Velcro tape 55. The internal fan guard 53 and the external fan guard 54 accommodate the motor 51 and the impeller 52 therein. As shown in FIG. 10B, the impeller 52 has a plurality of R-shaped blades 52a, a circular plate 52b and a motor shaft press-fit hole 52c. The plurality of blades 52a are attached around the circular plate 52b.

As shown in FIGS. 11A and 11B, the internal fan guard 53 has a circular bottom plate 53a, many fan guard poles 53b, and an annular flange 53c. The bottom plate 53a serves as a motor fixing plate. The fan guard poles 53b are substantially vertically disposed on the bottom plate 53a, and attached at predetermined intervals along a circumferential portion of the bottom plate 53a. These fan guard poles 53b function to prevent fingers from entering the internal fan guard 53. The flange 53c is attached at

an end portion of each fan guard pole 53b placed on the opposite side of the bottom plate 53a. Furthermore, as shown in FIG. 11C, the external fan guard 54 has a plurality of guard rings 54a having different radii and a flange 54b which fixes the plurality of guard rings 54a. Here, the Velcro tape 55 is attached to the outermost annular portion of the flange 54b as shown in FIG. 10A.

In order to assemble the air sending means 50, the motor 51 is first attached at the center of the bottom plate 53a of the internal fan guard 53. Then, the impeller 52 is accommodated in the internal fan guard 53 in such a manner that a rotary shaft of the motor 51 is inserted into the motor shaft press-fit hole 52c of the impeller 52. Thereafter, the external fan guard 54 is fixed on the internal fan guard 53, thereby bringing the air sending means 50 to completion.

An arrow shown in FIG. 10B indicates a rotating direction of the impeller 52. That is, the impeller 52 is a backward inclined impeller in which the blades 52a are backwardly bent with respect to the rotating direction. Therefore, when this impeller 52 rotates in a direction indicated by this arrow, air can be taken in from an axial direction of the impeller 52, and the air can be radially sent toward an outer peripheral direction of the impeller 52. The air sending means which radially sends the air taken in from the axial direction of the impeller toward the outer peripheral direction of the impeller will be also

referred to as a "a side stream fan" hereinafter.

Here, a diameter (a fan diameter) of the impeller 52 is approximately 5 cm. Furthermore, a value of an area obtained by summing up areas of opening portions for air intake or discharge in the two air sending means 50 and 50 (a total effective fan area) is approximately 30 cm^2.

As the air sending means 50 which is actually used in the first embodiment, there is employed means by which a flow quantity of air which can be generated between the clothing material portion 20 and the body or the undergarment is 6 liters/second. Here, when the air sending means 50 sends air having a flow quantity of 6 liters/second into the clothing material portion 20, a space in which the parallel-to-body airstream flows can be automatically formed between the clothing material portion 20 and the body by a pressure of this air. In order to automatically form this space, although depending on a type (hardness or a weight in particular) or a shape of the clothing material portion 20, it is generally necessary for the air sending means 50 to send air having a flow quantity of at least 2 liters/second. Moreover, when each of the two air sending means 50 and 50 sends air having a flow quantity of 6 liter/second, a power consumption of the two air sending means 50 and 50 is approximately 1 W.

The air sending means 50 is detachably attached to the clothing material portion 20. Specifically, as shown in FIG. 12A, the Velcro tape 22 is attached at the

circumferential part of the hole portion 21 on the inner surface of the clothing material portion 20. Assuming that this Velcro tape 22 is for a surface A, a Velcro tape for a surface B is a Velcro tape 55 attached to the flange 54b of the air sending means 50. On the inner surface side of the clothing material portion 20, when the air sending means 50 is arranged in such a manner that the external fan guard 54 of the air sending means 50 faces the hole portion 21 of the clothing material portion 20 and the two Velcro tapes 22 and 55 are attached, the air sending means 50 is attached at a position corresponding to the hole portion 21 of the clothing material portion 20 as shown in FIG. 12B. Since anyone can readily attach/detach the air sending means 50 in this manner, not only the air-conditioning garment 1 can be easily washed but also the air sending means 50 alone can be readily replaced when the air sending means 50 fails to operate properly.

It is to be noted that the method of attaching/detaching the air sending means 50 to/from the clothing material portion 20 is not restricted to the method using the Velcro tapes 22 and 55, and any method can be used as long as it is a method which can facilitate attachment/detachment of the air sending means 50 and has less air leak at the attachment portion of the air sending means 50. For example, a sheet-shaped magnet may be used to attach/detach the air sending means 50.

As shown in FIG. 9A, the power supply pocket 63

accommodates power supplying means 61 and is attached on the inner surface side of the clothing material portion 20 and at a lower left part on the front side of the clothing material portion 20. The power supplying means 61 supplies electric power to the air sending means 50 and 50. Here, a secondary battery is used as the power supplying means 61 in the light of economical efficiency. The power supplying means 61 and the two air sending means 50 and 50 are connected with each other through the power supply cable 62. Furthermore, a power supply switch (not shown) is provided between the power supplying means 61 and the two air sending means 50 and 50. This power supply switch turns on/off electric power which is supplied to the two air sending means 50 and 50 from the power supplying means 61.

Flow quantity adjusting means (not shown) for adjusting a flow quantity of air generated by the air sending means 50 and 50 is provided to the air-conditioning means 1. Here, for example, a volume is used as the flow quantity adjusting means. Since an excessive flow quantity of air can be prevented from flowing in the space between the clothing material portion 20 and the body by providing the volume, the life of the power supplying means 61 can be improved.

In the air-conditioning garment 1 according to the first embodiment, when the power supply switch provided between the power supplying means 61 and the air sending means 50 and 50 is turned on, the two air sending means 50

and 50 respectively take outside air into the clothing material portion 20. At this time, a space in which a parallel-to-body airstream flows is automatically formed between the clothing material portion 20 and the body or the undergarment by a pressure of the taken air. As a result, a flow of the parallel-to-body airstream with which the upper body is wrapped is generated in the space between the clothing material portion 20 and the body or the undergarment. Further, when the parallel-to-body airstream reaches the air circulating portions 40, 40 and 40, it is discharged to the outside from these portions. Here, arrows shown in FIG. 9 indicate a direction along which air is taken in from the outside and a direction along which air is discharged to the outside.

Since the air-conditioning garment 1 can circulate the parallel-to-body airstream in the space between the clothing material portion 20 and the body or the undergarment in this manner, a range in which the physiological cooler effectively functions can be expanded. At this time, the maximum capability of the physiological cooler is determined by a temperature/humidity of outside air. For example, in an environment indicated by the point A in FIG. 2 (a temperature of 35 °C and humidity of 30 %), when a flow quantity of air is 10 liters/second, heat radiation which is up to approximately 450 kilocalories/hour can be performed. In the air-conditioning garment 1, since a flow quantity of air is 6

liters/second, heat radiation which is up to 270 kilocalories/hour can be carried out. Therefore, when an adult having a regular physical size wears the air-conditioning garment 1 according to the first embodiment in this environment, liquid type perspiration is not involved even if a walking movement is performed at a speed of 5 km/hour, and he/she can comfortably walk. However, in calculation of a value of the above-described heat radiation quantity, transmission of heat by a temperature difference between a body temperature and a temperature of a parallel-to-body stream, cooling by aspiration and a cooling effect by vaporization of sweat from a skin which is not wrapped with the parallel-to-body airstream such as feet or a head are not taken into consideration.

A relationship between the clothing material portion 20 and the air guiding means will now be described. In the first embodiment, since air does not flow out from the hem portion of the clothing material portion 20, it can be considered that the parallel-to-body airstream rarely flows to a part lower than the air sending means 50 in the clothing material portion 20. Therefore, in a precise sense, it can be said that the entire clothing material portion 20 does not function as the air guiding means but only the part above the air sending means 60 in the clothing material portion 20 serves as the air guiding means. However, when the air sending means 60 is provided at a standard position, a large part of the clothing

material portion 20 functions to lead the parallel-to-body airstream, and hence it can be considered that the entire clothing material portion 20 is the air guiding means.

Moreover, a pressure difference between a pressure of outside air and a pressure in the air guiding means is increased as getting closer to the air sending means 50. Additionally, when an air sending mode of the air sending means 50 is an air intake mode and a flow quantity of air generated by the air sending means 50 is large, the air guiding means in the vicinity of the air sending means 50 is inflated by the pressure difference, and a so-called "air reservoir" is formed in the vicinity of the air sending means 50. Meanwhile, as described above, when air leaks from the air guiding means to the outside, the air-conditioning efficiency is lowered, and hence a material which has less air leak is used as the air guiding means. Practically, it is desirable for the air guiding means to have such air permeability as a ratio of a flow quantity of air leaking to the outside from the entire air guiding means with respect to a flow quantity of air taken into the space between the air guiding means and the body or the undergarment by the air sending means 50 and 50 is 60 % at the maximum.

An air-conditioning capability of the air-conditioning garment 1 according to the first embodiment will now be described in detail. Here, it is assumed that outside air is reference air (a temperature of 33 °C and

humidity of 50 %). Additionally, it is assumed that a surface of the body has enough sweat, the reference air is circulated as a parallel-to-body airstream between the clothing material portion 20 and the body to vaporize sweat, and a body temperature is cooled by vaporization heat of the sweat. Then, air discharged from the air circulating portion 50 has a temperature of 33 °C and humidity of 100 %. In such a case, an energy balance is calculated to obtain an air-conditioning capability as follows. It is to be noted that the temperature of the reference air is set to 33 °C because a surface temperature of the body is approximately 33 °C, therefore, an effect by dry heat can be ignored in calculation of the energy balance.

Now, a saturated water vapor quantity of air having a temperature of 33 °C is approximately 32.5 g/m^3. Therefore, when humidity of this air is 50 %, approximately 16.25 g/m^3 of water is contained in this air, and this air can afford to vaporize approximately 16.25 g/m^3 of water. Since vaporization heat of water is approximately 580 kilocalories/g, a vaporization enabling calorie of 1 m^3 of the reference air is 16.25 (g/m^3) × 580 (kilocalories/g), i.e., approximately 9.43 (kilocalories/m^3). In case of the air-conditioning garment for a light duty according to the first embodiment, since a flow quantity of the parallel-to-body airstream is approximately 6 liters/second, the volume of the parallel-to-body airstream which circulates in one hour is 0.006 (m^3/second) × 3600 (seconds) = 21.6 (m^3).

Therefore, the vaporization enabling calorie when the reference air is circulated as the parallel-to-body airstream for one hour is 9.43 (kilocalories/m^3) × 21.6 (m^3), i.e., approximately 203.7 (kilocalories), which corresponds to approximately 236.3 W. Here, as described above, this value is obtained without considering an effect by dry heat. Conversely, 33° which has no temperature difference from the surface temperature of the body is determined as a temperature of the reference air so that the effect by dry heat becomes zero. As described above, although a theoretical value of the air-conditioning capability of the air-conditioning garment 1 according to the first embodiment is 236.3 W, it can be considered that the air-conditioning capability is generally approximately 200 W when considering a vaporization contributing ratio of air (which is a ratio of air which contributes to vaporization of sweat with respect to circulated air when sweat is sufficiently supplied. This is improved as a flow of air gets closer to the body).

In the air-conditioning garment according to the first embodiment, since a flow quantity of air generated by the air sending means is 6 liters/second, the air-conditioning garment according to the first embodiment is preferable for a use in a case where a wearer performs a light duty.

Further, in the air-conditioning garment according to the first embodiment, since a wearer can use the flow

quantity adjusting means to adjust a flow quantity of air generated by the air sending means, noise caused due to the fan can be reduced or a power consumption can be decreased by reducing a flow quantity of air when an ambient temperature is not very high.

Furthermore, when small air permeability of the clothing material portion is conversely utilized, the air-conditioning garment according to the first embodiment can be used for preventing outside air from entering the clothing material portion like a windbreaker. In particular, when a temperature or a wind of a day greatly varies, using the air-conditioning garment for such a purpose is effective. Specifically, when an air temperature is low and a wind is strong, the air-conditioning garment is used as a windbreaker without sending air from the air sending means. Thereafter, when the air temperature is increased, air is sent from the air sending means, and the air-conditioning garment is used for its original purpose. As a result, a wearer can keep feeling comfortable without changing his/her garment in accordance with a change in a temperature or the like.

[Second Embodiment]

A second embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 13A is a schematic front view of an air-conditioning garment according to the second embodiment of the present invention, FIG. 13B is a

schematic rear view of the air-conditioning garment, FIG. 14A is a schematic plan view of an integrated belt used in the air-conditioning garment, and FIG. 14B is a view illustrating a state where the integrated belt is attached to a clothing material portion. Further, FIG. 15A is a schematic plan view of a local spacer used in the air-conditioning garment, FIG. 15B is a schematic side view of the local spacer, and FIG. 15C is a view illustrating a state where the local spacer is attached to the clothing material portion. It is to be noted that, in the second embodiment, like reference numerals denote parts having the same functions as those in the first embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 13, an air-conditioning garment 2 according to the second embodiment is provided with a clothing material portion 20, opening/closing means 31, lower air leak preventing means 32, three air circulating portions 40, 40 and 40, two air sending means 50 and 50, power supplying means 61, a power supply cable 62, a power supply pocket 63, an integrated belt 64, a power supply switch (not shown), and local spacers 70 and 70. This air-conditioning garment 2 is mainly used as a workwear utilized for medium duty (a garment for medium duty). Here, a main specification of this air-conditioning garment 2 is organized in the table of FIG. 5.

Main differences of the air-conditioning garment 2 according to the second embodiment from the air-

conditioning garment 1 according to the first embodiment lie in that an air-conditioning capability is 300 W, that the air-conditioning garment 2 has long sleeves, that the integrated belt 64 is used to attach/detach the air sending means 50 and 50 or the like to/from the clothing material portion 20 and that the local spacers 70 and 70 are provided at parts corresponding to shoulders of the clothing material portion 20. Any other points are the same as those in the first embodiment.

Characteristic points of the air-conditioning garment 2 according to the second embodiment will now be described in detail.

First, with an increase in air-conditioning capability of the air-conditioning garment 2 to 300 W, means capable of causing a parallel-to-body airstream to flow with a flow quantity of 9 liters/second is used as each of the air sending means 50 and 50. Here, a power consumption of the two air sending means 50 and 50 is approximately 1.5 W. Therefore, a cooling effect higher than that of the air-conditioning garment 1 according to the first embodiment can be obtained by wearing the air-conditioning garment 2. It is to be noted that means having a fan diameter of 60 mm is used as each of the air sending means 50 and 50. Furthermore, a total effective fan area of the two air sending means 50 and 50 is 45 cm^2.

Moreover, since the air-conditioning garment 2 has long sleeves, its air-conditioning area ratio is slightly

larger than that in the first embodiment. Specifically, the air-conditioning area ratio of the air-conditioning garment 2 is approximately 40 %. In this air-conditioning garment 2, arm parts can be also cooled.

The integrated belt 64 is a band-like member used to attach the two air sending means 50 and 50, the power supplying means 61, the power supply pocket 63, the power supply switch and others, and has a band-like base sheet 64a, two hole portions 64b and 64b formed in the base sheet 64a and a plurality of Velcro tapes 64c as shown in FIG. 14A. As the base sheet 64a, a vinyl sheet or the like is used. The air sending means 50 is inserted into each hole portion 64b to be attached. A distance between the two hole portions 64b and 64b is the same as a distance between the two hole portions 21 and 21 provided in the clothing material portion 20. Further, the power supply pocket 63 is attached to the base sheet 64a. The power supplying means 61 is accommodated in this power supply pocket 63. Furthermore, the power supplying means 61 and the two air sending means 50 and 50 are connected with each other through the power supply cable 62. Here, the power supply cable 62 is fixed on the base sheet 64a. The Velcro tapes 64c are attached at, e.g., predetermined positions of peripheral end portions of the base sheet 64a. Here, assuming that the Velcro tape 64c is for a surface A, a Velcro tape 23 for a surface B is attached at a predetermined position on an inner surface of the clothing

material portion 20 as shown in FIG. 14B.

The integrated belt 64 is detachably attached at a predetermined position on the inner surface side of the clothing material portion 20. Specifically, in case of attaching the integrated belt 64 to the clothing material portion 20, the integrated belt 64 is first arranged on the inner surface side of the clothing material portion 20 in such a manner that an external fan guard 54 of the air sending means 50 faces the hole portion 21 of the clothing material portion 20, and a Velcro tape 55 of the air sending means 50 and a Velcro tape 22 disposed around the hole portion 21 of the clothing material portion 20 are attached. As a result, the two air sending means 50 and 50 are respectively disposed at positions corresponding to the hole portions 21 and 21 of the clothing material portion 20. Then, each Velcro tape 64c of the integrated belt 64 is attached to the Velcro tape 23 disposed at a corresponding predetermined position of the clothing material portion 20, thereby fixing the integrated belt 64. In case of removing the air sending means 50 and 50, detaching the integrated belt 64 from the clothing material portion 20 can suffice. Therefore, when washing the air-conditioning garment 2, anyone can easily attach/detach the integrated belt 64.

It is to be noted that, since the vinyl sheet is used as the base sheet 64a, the base sheet 64a is hardly stained. Even if the base sheet 64a is stained, the stain can be readily rubbed away.

The local spacer 70 locally assures a space in which air is circulated between the clothing material portion 20 and a body. In the second embodiment, such local spacers 70 are provided at parts corresponding to both shoulders of the clothing material portion 20 on the inner surface side thereof. For example, when the air-conditioning garment 2 is heavy, a space for circulation of a parallel-to-body airstream cannot be automatically generated at the parts corresponding to the shoulders of the clothing material portion 20 in some cases. Therefore, in the second embodiment, the local spacers 70 are used to assuredly form the space for circulation of the parallel-to-body airstream at the parts corresponding to the shoulders of the clothing material portion 20.

As shown in FIGS. 15A and B, the local spacer 70 has a circular member 71 and a convex portion 72 formed at a central part of the circular member 71. As a material of this local spacer 70, a felt is used, for example. In case of attaching the local spacer 70 to the clothing material portion 20, first, as shown in FIG. 15C, the local spacer 70 is arranged on the inner surface side of the clothing material portion 20 in such a manner that the circular member 71 of the local spacer 70 faces the part corresponding to the shoulder of the clothing material portion 20. Then, an end portion of the circular member 71 of the local spacer 70 is sewn on the clothing material portion 20, thereby attaching the local spacer 70 to the

clothing material portion 20.

In the air-conditioning garment according to the second embodiment, since a flow quantity of air generated by the air sending means is 9 liters/second, the air-conditioning garment according to the second embodiment is preferable for a use in a case where a wearer performs a medium duty.

It is to be noted that the local spacer is not restricted to one having the above-described configuration, and any local spacer may be used as long as it has a configuration which can assuredly form a space for circulation of the parallel-to-body airstream between the clothing material portion and the body or an undergarment. Moreover, a position at which the local spacer is attached is not restricted to the shoulder, and the local spacer can be attached at an appropriate position as required.

[Third Embodiment]

A third embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 16A is a schematic front view of an air-conditioning garment according to the third embodiment of the present invention, and FIG. 16B is a schematic rear view of the air-conditioning garment. It is to be noted that, in the third embodiment, like reference numerals denote parts having the same functions as those in the first and second embodiments, thereby eliminating their detailed explanation.

As shown in FIG. 16, an air-conditioning garment 3 according to the third embodiment is provided with a clothing material portion 20a, opening/closing means 31, lower air leak preventing means 32, three air circulating portions 40, 40 and 40, two air sending means 50 and 50, power supplying means 61, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown), and local spacers 70 and 70. Here, the clothing material portion 20a functions as air guiding means. This air-conditioning garment 3 is mainly used as a workwear utilized for outdoor work on a rainy day (a workwear for rainy weather). Here, a main specification of this air-conditioning garment 3 is organized in the table of FIG. 5.

Main differences of the air-conditioning garment 3 according to the third embodiment from the air-conditioning garment 1 according to the first embodiment lie in that an air-conditioning capability is 500 W, that various countermeasure against rain are taken and that the local spacers 70 and 70 are provided at parts corresponding to shoulders of the clothing material portion 20a. Any other points are the same as those in the first embodiment.

Characteristic points of the air-conditioning garment 3 according to the third embodiment will now be described in detail.

First, with an increase in air-conditioning capability of the air-conditioning garment 3 to 500 W, means which can cause a parallel-to-body airstream to flow

with a flow quantity of 14 liters/second is used as each of the air sending means 50 and 50. Here, a power consumption of the two air sending means 50 and 50 is approximately 3 W. The air-conditioning capability is increased to 500 W because humidity is high on a rainy day, and quality of air which is taken into the air-conditioning garment 3 is poor. That is, as described above, a notational value of the air-conditioning capability in FIG. 5 is a value at a temperature of 33 °C and humidity of 50 %. Therefore, when quality of air which is taken into the clothing material portion 20a is poor, e.g., when humidity is extremely high, an actual air-conditioning capability is lower than the air-conditioning capability represented in FIG. 5. Even though the quality of air is poor, more air can be caused to flow in a space between the clothing material portion 20a and a body by wearing the air-conditioning garment 3, thereby obtaining a sufficient cooling effect even on a rainy day. It is to be noted that means having a fan diameter of 70 mm is used as each of the air sending means 50 and 50. Further, a total effective fan area of the two air sending means 50 and 50 is 62 cm^2.

Various kinds of countermeasure against rain are taken in the air-conditioning garment 3 according to the third embodiment. First, the clothing material portion 20a is formed into a shape which covers an upper body and a head region excluding a face. Specifically, each arm part of the clothing material portion 20a is formed into a long-

sleeved shape, and a hood 25 is provided to the clothing material portion 20a. Since the hood 25 is provided, the head region can be prevented from getting wet with rain during work, and a range in which the physiological cooler effectively functions can be expanded to the head region. In this case, an opening portion at the hood 25 part (a part around a neck) and opening portions at left and right cuff parts become the air circulating portions 40, 40 and 40. Moreover, since the hood 25 is provided to the clothing material portion 20a, an air-conditioning area ratio of the air-conditioning garment 3 is approximately 60 % which is larger than that in the first embodiment.

As a material of the clothing material portion 20a, a material which does not absorb rain water, e.g., a plastic sheet such as a vinyl sheet is used. Besides the plastic sheet, a rubber sheet, a waterproof cloth or the like can be used. In this manner, the clothing material portion 20a is hardly stained.

Additionally, the air sending means 50 and 50 are subjected to water-resistant processing. The air sending means 50 and 50 are fixed on the clothing material portion 20a so that the air sending means 50 and 50 cannot be removed from the clothing material portion 20a.

In the air-conditioning garment according to the third embodiment, since a flow quantity of air generated by the air sending means is 14 liters/second, the air-conditioning garment according to the third embodiment is

preferable for a use in a case where a wearer performs outdoor work on a rainy day. Actually, various countermeasures against rain are taken in the air-conditioning garment according to the third embodiment. Therefore, when this air-conditioning garment is used in the rain, the body can be prevented from being sticky, and hence a wearer can comfortably perform work. Further, the air-conditioning garment itself is hardly stained, and the stain can be readily rubbed away even if the air-conditioning garment is stained.

[Fourth Embodiment]

A fourth embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 17A is a schematic front view of an air-conditioning garment according to the fourth embodiment of the present invention, and FIG. 17B is a schematic rear view of the air-conditioning garment. It is to be noted that, in the fourth embodiment, like reference numerals denote parts having the same functions as those in the second embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 17, an air-conditioning garment 4 according to the fourth embodiment is provided with a clothing material portion 20, opening/closing means 31, lower air leak preventing means 32, three air circulating portions 40, 40 and 40, two air sending means 50 and 50, a power supply cable 62, an integrated belt 64, a DC adapter

(DC converting means) 65, a power supply switch (not shown) and local spacers 70 and 70. This air-conditioning garment 4 is mainly used as a workwear utilized for a work in a manufacturing line (a garment for a line operation). Here, in the manufacturing line, a worker performs a manufacturing operation in a sitting posture. It is to be noted that a main specification of this air-conditioning garment 4 is organized in the table of FIG. 5.

A main difference of the air-conditioning garment 4 according to the fourth embodiment from the air-conditioning garment 2 according to the second embodiment lies in that electric power is supplied to the air sending means 50 and 50 from a commercial power source. That is, a commercial power source is used as the power supplying means. Therefore, the air sending means 50 and 50 alone are disposed to the integrated belt 64, and a secondary battery is not attached. Furthermore, means which can cause a parallel-to-body airstream to flow with a flow quantity of 9 liters/second is used as each of the air sending means 50 and 50. Any other points are the same as those in the second embodiment.

Characteristic points of the air-conditioning garment 4 according to the fourth embodiment will now be described in detail.

In the fourth embodiment, electric power is supplied to the two air sending means 50 and 50 from the commercial power source. Therefore, an alternating voltage from the

commercial power source is converted into a direct-current voltage by using the DC adapter 65, and the converted direct-current voltage is supplied to the two air sending means 50 and 50 through the power supply cable 62. As a result, even if time for a labor with use of the air-conditioning garment 4 is prolonged, it is not necessary to be very sensitive about a power consumption as different from a case where a battery is used as the power source like the second embodiment, and hence a wearer can concentrate on the labor.

Moreover, in the fourth embodiment, since it is not necessary to be very sensitive about a power consumption of the air sending means 50, means having a small fan diameter is used as each air sending means 50, and each air sending means 50 is rotated at a high speed. The air sending means 50 having a small fan diameter is used in order to prevent the air sending means 50 from coming into contact with a body even if a wearer leans back in a chair. Actually, in the fourth embodiment, means having a fan diameter of 40 mm is used as each of the air sending means 50 and 50. Additionally, a total effective fan area of the two air sending means 50 and 50 is 20 cm^2. Further, a power consumption of the two air sending means 50 and 50 is approximately 20 W.

It is to be noted that, when a wearer moves away from a chair, he/she must disconnect the power supply cable 62 which connects the DC adapter 65 and the air sending means

50 and 50. Therefore, there is a problem that a cooling effect by the air-conditioning garment 4 cannot be obtained when he/she is away from the chair. In order to solve this problem, it is good enough to dispose, e.g., a secondary battery having a small capacity to the integrated belt 64. When the power supply cable 62 which connects the DC adapter 65 and the air sending means 50 and 50 is disconnected, electric power is supplied to the air sending means 50 and 50 from the secondary battery, whereby the air sending means 50 and 50 can be driven in a short time without supply of power from a commercial power source.

In the air-conditioning garment according to the fourth embodiment, since a flow quantity of air generated by the air sending means is 9 liters/second and electric power is supplied to the air sending means from the commercial power source by using the DC adapter, the air-conditioning garment according to the fourth embodiment is preferable for a use in a case where a wearer performs medium duty in a sitting posture.

[Fifth Embodiment]

A fifth embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 18A is a schematic front view of an air-conditioning garment according to the fifth embodiment of the present invention, and FIG. 18B is a schematic rear view of the air-conditioning garment. It is to be noted that, in the fifth embodiment, like reference numerals

denote parts having the same functions as those in the first embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 18, an air-conditioning garment 5 according to the fifth embodiment is provided with a clothing material portion 200, opening/closing means 31a, four air circulating portions 40, 40, 40 and 40a, two air sending means 50 and 50, power supplying means 61, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown), and a pressure-proof spacer 80. This air-conditioning garment 5 is mainly use as a uniform for office work (a garment for office use). Here, a main specification of this air-conditioning garment 5 is organized in the table of FIG. 6.

Main differences of the air-conditioning garment 5 according to the fifth embodiment from the air-conditioning garment 1 according to the first embodiment lie in that a cloth having high air permeability is used for an upper portion of the clothing material portion 200, that a lower portion of the clothing material portion 200 is formed rather long so that buttocks and the lower abdominal region of a wearer can be covered, that a button is used as the opening/closing means 31a and that the pressure-proof spacer 80 is provided in the clothing material portion 200. Further, as each of the air sending means 50 and 50, means which can cause a parallel-to-body airstream to flow with a flow quantity of 6 liters/second is used. Furthermore, the

air-conditioning area ratio of this air-conditioning garment 5 is approximately 40 %. Any other points are the same as those in the first embodiment.

Characteristic points of the air-conditioning garment 5 according to the fifth embodiment will now be described in detail.

In the fifth embodiment, the clothing material portion 200 is divided into an upper portion excluding arm portions and a portion other than the upper portion (arm portions and a lower portion), and different material are used for these respective portions. That is, a cloth having high air permeability is used for the upper portion of the clothing material portion 200, and a cloth having low air permeability such as a polyester cloth is used for the arm portions and the lower portion of the clothing material portion 200. In the fifth embodiment, only the portion (the arm portions and the lower portion) formed out of the cloth having low air permeability in the clothing material portion 200 serves as air guiding means. Moreover, like the first embodiment, upper opening portions function as the air circulating portions 40, 40 and 40, and the portion (the upper portion) formed out of the cloth having high air permeability in the clothing material portion 200 also serves as an air circulating portion 40a. This air circulating portion 40a functions to assist circulation of air by the upper opening portions. For example, when a necktie or the like is put on, air cannot be circulated

from the opening portion at a part around the neck in the upper opening portions. In such a case, the air circulating portion 40a substitutes for the opening portion at a part around the neck.

In case of manufacturing such a clothing material portion 200, it is good enough to perform sewing using different materials for the upper portion and for the arm portions and the lower portion, or, to manufacture the entire clothing material portion 200 by using a cloth having high air permeability and then stitch a cloth having low air permeability on the arm portions and the lower portion of the clothing material portion 200. However, the clothing material portion becomes seamy if these methods are adopted, whereby an appearance of the air-conditioning garment 5 may be deteriorated in some cases. As a method which solves this problem, there can be considered a method of first manufacturing the entire clothing material portion 200 by using a cloth having high air permeability and then laminating a sheet having low air permeability on the arm portions and the lower portion of the clothing material portion 200 from the inner side thereof. In this case, a part on which the sheet-shaped member having low air permeability is laminated from the inner side in the clothing material portion 200 serves as the air guiding means, and a part on which this sheet-shaped member is not laminated in the clothing material portion 200 functions as the air circulating portion 40a.

Moreover, the lower portion of the clothing material portion 200 is formed rather long so that buttocks and the lower abdominal region of a wearer can be covered like a general dress shirt. In this example, a hem portion of the clothing material portion 200 is not subjected to any processing, e.g., providing a rubber belt or the like. In the fifth embodiment, in case of putting on the air-conditioning garment 5, when a portion lower than a part indicated by X in FIG. 18 in the clothing material portion 200 is tucked into pants or the like, air can be prevented from leaking to the outside from the hem portion of the clothing material portion 200.

In the fifth embodiment, buttons used for a dress shirt or the like are adopted as opening/closing means 31a. Meanwhile, when the buttons are fastened, an end portion of the clothing material portion 200 on a side where the buttons are attached is positioned on the inner side, and an end portion of the clothing material portion 200 on a side where button holes are formed is positioned on the outer side, whereby an overlapping portion of the clothing material portion 200 is formed. At this time, if a width of the overlapping portion is substantially the same as a width of an overlapping portion in a general dress shirt, a large part of a parallel-to-body airstream sent from the air sending means 50 leaks from the overlapping portion to the outside, thereby considerably reducing an air-conditioning capability of the air-conditioning garment for

office use. In order to improve this problem, there can be considered a method of increasing the number of buttons and narrowing distances between the buttons to decrease a gap generated in the overlapping portion. In this method, however, since the number of buttons is increased, an uncomfortable feeling about an appearance is produced when the air-conditioning garment 5 is put on. Furthermore, there occurs another problem that a large time is required to fasten or unfasten the buttons. Therefore, it cannot be said this is a very practical method. Thus, in the fifth embodiment, an extending portion 201 is provided at the end portion of the clothing material portion 200 on the side where the buttons are attached. That is, extending the end portion of the clothing material portion 200 on the side where the buttons are attached increases an area of the overlapping portion of the clothing material portion 200 which is produced when the buttons are fastened. As a result, the problem of leak of air to the outside from the overlapping portion can be sufficiently improved without deteriorating the appearance or the like of the air-conditioning garment 5. It is to be noted that air leaks from the overlapping portion in a measure even in this case, but the air-conditioning garment 5 has the practically sufficient air-conditioning capability when the air-conditioning garment 5 is used as a garment for office use.

Incidentally, of course, the extending portion 201 does not have to be necessarily provided at the end portion

of the clothing material portion 200 on the side where the buttons are attached depending on an intended purpose of the air-conditioning garment 5. For example, the overlapping portion of the clothing material portion 200 which is produced when the buttons are fastened can be utilized as one of the air circulating portions.

In the fifth embodiment, a pressure-proof spacer 80 is attached at a part corresponding to the back region on the inner surface side of the clothing material portion 200. The pressure-proof spacer 80 assures a space in which air is circulated between the clothing material portion 200 and a body or an undergarment, and has strength which can resist a large pressure. In particular, in the fifth embodiment, the pressure-proof spacer 80 is used to prevent a parallel-to-body airstream from not flowing in the vicinity of the back region when a wearer leans back in a chair and the clothing material portion 200 and the body or the undergarment thereby become appressed against each other. The requirements for the pressure-proof spacer 80 are that it can resist a large pressure, and that a resistance which air receives from it is low and air can readily circulate.

A configuration of the pressure-proof spacer 80 will now be described. FIG. 19A is a schematic plan view of a part of the pressure-proof spacer 80, and FIG. 19B is a schematic side view of a part of the pressure-proof spacer 80. The pressure-proof spacer 80 is a so-called mesh

spacer, and has a net-like sheet (a net-like member) 81 and a plurality of convex portions 82 as shown in FIG. 19. In this example, each convex portion 82 is formed into a substantially semispherical shape. In order to manufacture this pressure-proof spacer 80, the net-like sheet formed of soft plastic is put between a convex metal mold and a concave metal mold and subjected to thermoforming. As a result, the plurality of convex portions 82 protruding in a thickness direction of the net-like sheet are formed on the net-like sheet. In this manner, the pressure-proof spacer 80 can be readily formed.

Additionally, it is desirable for the pressure-proof spacer 80 to have a thickness (a height of the convex portion 82) W which is not smaller than 2 mm and not larger than 30 mm. When the thickness W of the pressure-proof spacer 80 is smaller than 2 mm, a pressure of air must be largely increased in order to circulate air having a fixed flow quantity, which is not practical. In particular, since a flow of air is large around the air sending means 50 and 50, it is desirable for the pressure-proof spacer 80 provided around the air sending means 50 and 50 to have the thickness W which is not smaller than 5 mm. On the other hand, when the thickness W of the pressure-proof spacer 80 is larger than 30 mm, the appearance or comfortableness is deteriorated. In reality, the most preferable range for the thickness W of the pressure-proof spacer 80 is not smaller than 3 mm and not larger than 10 mm.

The pressure-proof spacer 80 is stitched on a part of the clothing material portion 200 corresponding to the back region. Specifically, the pressure-proof spacer 80 is arranged on the part of the clothing material portion 200 corresponding to the back region in such a manner that the net-like sheet 81 of the pressure-proof spacer 80 faces the clothing material portion 200 from the inner surface side of the clothing material portion 200. Further, the pressure-proof spacer 80 is, for example, sewed on the clothing material portion 200 by using a sewing machine or the like.

In the air-conditioning garment according to the fifth embodiment, since a flow quantity of air generated by the air sending means is 6 liters/second, the air-conditioning garment according to the fifth embodiment is preferable for a use in a case where a wearer performs work in an office.

[Sixth Embodiment]

A sixth embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 20A is a schematic front view of an air-conditioning garment according to the sixth embodiment of the present invention, FIG. 20B is a schematic rear view of the air-conditioning garment, and FIG. 20C is a schematic front view of an undergarment which is put on under the air-conditioning garment. It is to be noted that, in the sixth embodiment, like reference numerals denote parts

having the same functions as those in the fifth embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 20, an air-conditioning garment 6 according to the sixth embodiment is provided with a clothing material portion 200, opening/closing means 31a, four air circulating portions 40, 40, 40 and 40a, two air sending means 50 and 50, power supplying means 61, a power supply cable 62, a power supply pocket 63, a solar battery 66, a power supply switch (not shown), and a pressure-proof spacer 80. This air-conditioning garment 6 is mainly used as a garment which is put on at the time of an outdoor activity for a long time (a garment for outdoor). Furthermore, the air-conditioning garment 6 is put on over a predetermined undergarment shown in FIG. 20C. Here, a main specification of this air-conditioning garment 6 is organized in the table of FIG. 6.

Main differences of the air-conditioning garment 6 according to the sixth embodiment from the air-conditioning garment 5 according to the fifth embodiment lie in that an air-conditioning capability is 400 W, that the clothing material portion 200 is subjected to waterproof processing or water-repellent processing, and that a secondary battery as the power supplying means 61 is charged by using the solar battery 66. Any other points are the same as those in the fifth embodiment.

Characteristic points of the air-conditioning garment 6 according to the sixth embodiment will now be described

in detail.

Since the air-conditioning garment 6 is used for an outdoor activity, its air-conditioning capability is improved to 400 W. With this improvement, as each of the air sending means 50 and 50, means which can cause a parallel-to-body airstream to flow with a flow quantity of 12 liters/second is used. Here, a power consumption of the two air sending means 50 and 50 is approximately 2.5 W. Furthermore, a fan diameter of each air sending means 50 is 55 mm, and a total effective fan area of the two air sending means 50 and 50 is 38 cm^2. Moreover, the clothing material portion 200 is subjected to waterproof processing or water-repellent processing as a countermeasure against rain.

Additionally, the air-conditioning garment 6 is provided with the solar battery 66 which charges the secondary battery as the power supplying means 61. This solar battery 66 is disposed at a position on an outer surface side of the clothing material portion 200 corresponding to an upper back region. The solar battery 66 is connected with the secondary battery through the power supply cable 62. As a result, the solar battery 66 charges the secondary battery, and electric power is supplied to the air sending means 50 and 50 from this secondary battery. It is to be noted that the solar battery 66 may be used as the power supplying means so that electric power from the solar battery 66 can be directly

supplied to the air sending means 50 and 50.

The air-conditioning garment 6 according to the sixth embodiment is put on over an undergarment. As shown in FIG. 20C, the local spacers 70 and 70 are attached at parts on an outer surface side of the undergarment corresponding to both shoulders. Here, a configuration of the local spacer 70 is the same as that described in the second embodiment. Since the local spacers 70 and 70 are provided to the undergarment, a space in which air is circulated is assuredly formed between the clothing material portion 200 and the undergarment when the air-conditioning garment 6 is put on over the undergarment.

In the air-conditioning garment according to the sixth embodiment, a flow quantity of air generated by the air sending means is 12 liters/second, and the clothing material portion is subjected to waterproof processing or water-repellent processing. Therefore, the air-conditioning garment according to the sixth embodiment is preferable for a use in a case where a wearer performs an outdoor activity for a long time.

[Seventh Embodiment]

A seventh embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 21A is a schematic front view of an air-conditioning garment according to the seventh embodiment of the present invention, FIG. 21B is a schematic rear view of the air-conditioning garment, and

FIG. 22 is a view illustrating air sending means used in the air-conditioning garment. It is to be noted that, in the seventh embodiment, like reference numerals denote parts having the same functions as those in the fifth embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 21, an air-conditioning garment 7 according to the seventh embodiment is provided with a clothing material portion 200, opening/closing means 31a, four air circulating portions 40, 40, 40 and 40a, two air sending means 500 and 500, power supplying means 61, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown), and a planar spacer 90. This air-conditioning garment 7 is mainly used as a garment which prevents an undergarment from smelling of sweat (a garment for deodorization). Therefore, this air-conditioning garment 7 is put on over the undergarment. Here, a main specification of the air-conditioning garment 7 is organized in the table of FIG. 6.

Main differences of the air-conditioning garment 7 according to the seventh embodiment from the air-conditioning garment 5 according to the fifth embodiment lie in that an air-conditioning capability is 20 W, that a discharge mode is adopted as an air sending mode of the air sending means 500, and that the planar spacer 90 is provided on the clothing material portion 200. And the air-conditioning area ratio is approximately 35 % in the air-conditioning garment 7. Any other points are the same as

those in the fifth embodiment.

Characteristic points of the air-conditioning garment 7 according to the seventh embodiment will now be described in detail.

A main object of the air-conditioning garment 7 according to the seventh embodiment is to rapidly vaporize sweat and prevent the undergarment from smelling of sweat, and it is not necessarily to cool a body. Therefore, the air-conditioning capability of the air-conditioning garment 7 is greatly reduced to 20 W. With this reduction, as each of the air sending means 500 and 500, means which can cause a parallel-to-body airstream to flow with a flow quantity of 0.6 liter/second is used. Here, a power consumption of the two air sending means 500 and 500 is approximately 0.15 W. Since a flow quantity of air generated by the air sending means 500 and 500 is small as described above, noise caused by the air sending means 500 and 500 is very small. It is to be noted that means having a fan diameter of 20 mm is used as each of the air sending means 500 and 500. And a total effective fan area of the two air sending means 500 and 500 is 4 cm^2.

Actually, even if a person who is sensitive to heat or a person who has temporarily performed a heavy duty (e.g., going up and down stairs) stays in a room such as an office where an air conditioner is effectively working to some extent, sweat remains in an undergarment, and the undergarment smells of sweat. In such a case, when the

air-conditioning garment 7 is put on over the undergarment, a parallel-to-body airstream can be caused to flow between the clothing material portion 200 and the undergarment. Therefore, sweat which has remained in the undergarment can be rapidly vaporized. Accordingly, it is possibly to prevent sweat from remaining in the undergarment for a long time and the undergarment from smelling of sweat.

In the seventh embodiment, the discharge mode is adopted as an air sending mode of the air sending means 500. In this discharge mode, the air sending means 500 discharges air in the clothing material portion 200 to the outside, whereby a parallel-to-body airstream flows in a space between the clothing material portion 200 and a body (or the undergarment). Therefore, in the seventh embodiment, such a propeller fan as shown in FIG. 22 is used as the air sending means 500.

As shown in FIG. 22, the air sending means 500 has a propeller 501, a motor (not shown), a casing 502, an external fan guard (not shown), and gap holding means (not shown). The propeller 501 is coupled with a rotary shaft of the motor. Further, the propeller 501 and the motor are accommodated in the casing 502. The external fan guard is attached to this casing 502. The external fan guard prevents fingers from entering the casing 502. The air sending means 500 is attached to the clothing material portion 200 from its inner surface side in such a manner that a rotation axis of the propeller 501 becomes

substantially vertical to a surface of the clothing material portion 200. As a method of attaching the air sending means 500 to the clothing material portion 200, it is possible to use the method utilizing a Velcro tape described in the first embodiment. Furthermore, gap holding means is provided on a side of the air sending means 500 facing the body. This gap holding means maintains a gap between the propeller 501 and the body at a fixed value H.

When electric power is supplied from the power supplying means 61 to the air sending means 500 and 500, the propeller 501 rotates in a direction along which air in the clothing material portion 200 is discharged to the outside. Here, in FIG. 22, arrows indicate a flow of air.

It is to be noted that a flow quantity of air generated by the air sending means 500 is small in the seventh embodiment, and hence small means can be used as the air sending means 500. Therefore, even if the air-conditioning garment 7 is put on, there is almost no uncomfortable feeling about the appearance. Moreover, when an air discharge opening of the air sending means 500 is covered with a cloth having good air permeability, the air sending means 500 can be hidden from the outside.

Meanwhile, since the discharge mode is adopted as the air sending mode of the air sending means 500, when the air sending means 500 and 500 are driven, a pressure in a space between the clothing material portion 200 and the body (the

undergarment) becomes a negative pressure with respect to an outside air pressure. Therefore, when the discharge mode is adopted as the air sending mode, a method of utilizing a pressure of air generated by the air sending means like the first embodiment cannot be adopted as a method of forming a space in which a parallel-to-body airstream is circulated. In general, in a case where the discharge mode is adopted as the air sending means, if a flow quantity of air generated by the air sending means is larger than 6 liters/second, a difference between an outside air pressure and a pressure in the clothing material portion becomes large although it depends on characteristics (e.g., hardness or a weight) or a shape of the air guiding means. Therefore, it is very difficult to assure a space in which the parallel-to-body airstream is circulated.

In the seventh embodiment, in order to assure the space in which the parallel-to-body airstream is circulated, the planar spacer 90 is attached to the clothing material portion 200. Specifically, the planar spacer 90 is attached at a part on an inner surface side of the clothing material portion 200 corresponding to the air sending means 500 and 500 and an upper part than that part. This planar spacer 90 assures a space in which air is circulated between the clothing material portion 200 and the body (the undergarment). The requirement for the planar spacer 90 is that a resistance which air receives from the planar spacer

90 is low. It is to be noted that the planar spacer 90 also functions as a pressure-proof spacer. Therefore, as the planar spacer 90, it is possible to use one having the same configuration as that of the pressure-proof spacer 80. In particular, it is desirable to use a light and flexible spacer as the planar spacer 90 attached on the clothing material portion 200 corresponding to an abdominal region or a chest region requiring no resistance to pressure.

The planar spacer 90 is sewed on the part on the inner surface side of the clothing material portion 200 corresponding to the air sending means 500 and 500 and the upper part than that part. Specifically, the planar spacer 90 is first arranged at a predetermined position of the clothing material portion 200 in such a manner that a net-like sheet of the planar spacer 90 faces the inner surface of the clothing material portion 200. Additionally, a sewing machine or the like is used to sew the planar spacer 90 on the inner surface of the clothing material portion 200. At this time, it is desirable to sew an end portion alone of the planar spacer 90 on the clothing material portion 200. That is because, a sewing operation of the planar spacer 90 can be facilitated and a seam can be made less noticeable in the appearance of the air-conditioning garment 7.

It is to be noted that the planar spacer 90 does not have to be one continuous spacer, and it may be divided into several parts for facilitation of sewing or the like.

Further, it is not required to necessarily attach the planar spacer 90 to the part of the clothing material portion 200 corresponding to the air sending means 500 and 500 and the upper part than that part, and it may be disposed at each necessary position.

When the air-conditioning garment 7 having the planar spacer 90 sewed thereon as described above is put on, a convex portion of the planar spacer 90 comes into contact with a surface of the body (the undergarment), and a space in which air is circulated is assured between the clothing material portion 200 and the body (the undergarment). Therefore, when the air sending means 500 and 500 are driven, outside air enters the space between the clothing material portion 200 and the body (the undergarment) from the air circulating portions 40, 40, 40 and 40a, flows to wrap the upper body as a parallel-to-body airstream, and is discharged to the outside from the air sending means 500 and 500.

As described above, in the air-conditioning garment according to the seventh embodiment, vaporization of slowly effective perspiration is facilitated, and the undergarment can be prevented from smelling of sweat.

[Eighth Embodiment]

An eighth embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 23A is a schematic front view of an air-conditioning garment according to the eighth

embodiment of the present invention, and FIG. 23B is a schematic rear view of the air-conditioning garment. It is to be noted that, in the eighth embodiment, like reference numerals denote parts having the same functions as those in the seventh embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 23, an air-conditioning garment 8 according to the eighth embodiment is provided with a clothing material portion 210, opening/closing means 31a, attaching/detaching means 33, four air circulating portions 40, 40, 40 and 40a, two air sending means 500 and 500, power supplying means 61, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown), and planar spacers 90 and 90. This air-conditioning garment 8 is mainly used as a garment which is put on by a young child having a weight of approximately 10 to 15 kg (a garment for children). Here, a main specification of this air-conditioning garment 8 is organized in the table of FIG. 6.

Main differences of the air-conditioning garment 8 according to the eighth embodiment from the air-conditioning garment 7 according to the seventh embodiment lie in that an air-conditioning capability is 50 W and that the clothing material portion 210 can be divided into upper and low parts. Any other points are the same as those in the seventh embodiment.

Characteristic points of the air-conditioning garment

8 according to the eighth embodiment will now be described in detail.

In the eighth embodiment, a wearer is a young child, his/her weight is light, and his/her thermogenetic quantity is small. Therefore, the air-conditioning capability of the air-conditioning garment 8 is set to 50 W. In addition to this, means which can cause a parallel-to-body airstream to flow with a flow quantity of 1.4 liters/second is used as each of the air sending means 500 and 500. Here, a power consumption of the two air sending means 500 and 500 is approximately 0.3 W. It is to be noted that means having a fan diameter of 25 mm is used as each of the air sending means 500 and 500. And a total effective fan area of the two air sending means 500 and 500 is 7 cm^2.

Further, children are apt to stain their garments, the clothing material portion 210 is configured to be divided into two parts, i.e., upper and lower parts for facilitating washing. Here, an upper part of the clothing material portion 210 is referred to as an upper clothing material portion 210a and a lower part of the same is referred to as a lower clothing material portion 210b.

The upper clothing material portion 210a is configured like the clothing material portion in the seventh embodiment. That is, in the upper clothing material portion 210a, a part formed by using a cloth having low air permeability (arm portions and a lower portion) serves as air guiding means, and a part formed by

using a cloth having high air permeability (an upper portion) functions as the air circulating portion 40a. On the other hand, the lower clothing material portion 210b serves as air guiding means. In particular, as a material of the lower clothing material portion 210b, a vinyl sheet or the like is used. As a result, when the lower clothing material portion 210b is stained, the stain can be readily removed by wiping off this stain.

Furthermore, to the lower clothing material portion 210b are attached the two air sending means 500 and 500, the power supplying means 61, the power supply cable 62, the power supply pocket 63, the power supply switch (not shown) and the planar spacers 90.

The upper clothing material portion 210a and the lower clothing material portion 210b are attached to each other by the attaching/detaching means 33. As this attaching/detaching means 33, it is possible to use, e.g., a fastener or a Velcro tape. In this manner, the upper clothing material portion 210a and the lower material clothing portion 210b can be readily attached/detached. In case of washing the air-conditioning garment 8, it is good enough to remove the upper clothing material portion 210a and the lower clothing material portion 210b, wash the upper clothing material portion 210a in a regular manner and wipe off stains from the lower clothing material portion 210b. Incidentally, it can be considered that the lower clothing material portion 210b also serves as the

integrated belt described in the second embodiment.

[Ninth Embodiment]

A ninth embodiment according to the present invention will now be described with reference to accompanying drawings. FIG. 24A is a schematic front view of an air-conditioning garment according to the ninth embodiment of the present invention, and FIG. 24B is a schematic rear view of the air-conditioning garment. It is to be noted that, in the ninth embodiment, like reference numerals denote parts having the same functions as those in the first and second embodiments, thereby eliminating their detailed description.

As shown in FIG. 24, an air-conditioning garment 9 according to the ninth embodiment is provided with a clothing material portion 20, opening/closing means 31, lower air leak preventing means 32, six air circulating portions 40, 40, 40, 40b, 40b and 40b, one air sending means 50, power supplying means 61a, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown) and local spacers 70 and 70. This air-conditioning garment 9 is mainly used as a workwear utilized for a heavy physical labor (a garment for a heavy duty). Here, a main specification of this air-conditioning garment 9 is organized in the table of FIG. 7.

Main differences of the air-conditioning garment 9 according to the ninth embodiment from the air-conditioning garment 1 according to the first embodiment lie in that an

air-conditioning capability is 2000 W, that one air sending means 50 alone is provided, that as well as upper opening portions 40, 40 and 40, three auxiliary opening portions 40b, 40b and 40b are provided as the air circulating portions, and that a fuel battery is used as the power supplying means 61a. Moreover, in the ninth embodiment, the local spacers 70 and 70 are provided at parts on an inner surface side of the clothing material portion 20 corresponding to both shoulders like the second embodiment. Any other points are the same as those in the first embodiment.

Characteristic points of the air-conditioning garment 9 according to the ninth embodiment will now be described in detail.

Since the air-conditioning garment 9 according to the ninth embodiment is used when performing a heavy duty, the air-conditioning capability is increased to 2000 W. In addition to this, means which can cause a parallel-to-body airstream to flow with a flow quantity of 60 liters/second is used as the air sending means 50. Here, a power consumption of the air sending means 50 is approximately 20 W.

Since an air sending capability required for the air sending means 50 is very high, the air sending means 50 which is actually used has a large fan diameter and heavy weight. For example, a fan diameter of the air sending means 50 is at least 100 mm. Actually, in the ninth

embodiment, means having a fan diameter of 150 mm and a total effective fan area of 150 cm^2 is used as the air sending means 50. Therefore, when the air sending means 50 is attached on the clothing material portion 20 so that a weight of the air sending means 50 is received by the clothing material portion 20 alone, there are various problems. For example, the air sending means 50 readily comes off the clothing material portion 20. Thus, in the ninth embodiment, an ingenuity is exercised with respect to an attachment method of the air sending means 50.

Specifically, one large hole portion is provided at a central part of a back region of the clothing material portion 20, and the air sending means 50 is disposed to this hole portion. Here, a structure and an attachment/detachment method of the air sending means 50 are basically the same as those described in the first embodiment. Further, in the ninth embodiment, a sling (slinging means) 56 for carrying the air sending means 50 on a wearer's back is provided at the air sending means 50. The wearer puts the sling 56 on his/her shoulders to carry the air sending means 50 on his/her back. As a result, a weight of the air sending means 50 can be received by not only the clothing material portion 20 but also the shoulders of the wearer. Therefore, the air sending means 50 can be prevented from readily coming off the clothing material portion 20. It is to be noted that one which supports the weight of the air sending means 50 from the

outside of the clothing material portion 20 does not have to be necessarily used as the slinging means, and the slinging means may be attached inside of the clothing material portion 20 or stitched on an inner surface of the clothing material portion 20.

Furthermore, when the air sending means 50 is disposed at the back part of the clothing material portion 20 and means which can generate air which flows with a flow quantity of at least 10 liters/second is used as the air sending means 50, the air-conditioning garment 9 which is very rational to be used as a workwear for a work in a standing position can be obtained. In particular, when one air sending means 50 alone is provided at a part corresponding to the back region of the clothing material portion 20 and means which can generate air which flows with a flow quantity of at least 15 liters/second between the clothing material portion 20 and a body or an undergarment is used as the air sending means 50, a utility workwear for a work in a standing position can be manufactured at the lowest cost. It is to be noted that a fan diameter of the air sending means 50 must be at least 60 mm in order to cause air to flow with a flow quantity of 15 liters/second between the clothing material portion 20 and the body or the undergarment.

Moreover, in order to cause a large quantity of a parallel-to-body airstream to flow in a space between the clothing material portion 20 and the body or the

undergarment, a corresponding quantity of air must be able to flow to the outside. Therefore, in the ninth embodiment, three auxiliary opening portions 40b, 40b and 40b as well as the upper opening portions 40, 40 and 40 are provided as the air circulating portions. The three auxiliary opening portions 40b, 40b and 40b are respectively provided at a front left part, a front right part and an upper part of the back in the clothing material portion 20. The auxiliary opening portion 40b is formed by, e.g., boring a hole at a predetermined position of the clothing material portion 20 and stitching a material having good air permeability on the clothing material portion 20 to close this hole. Here, as a cloth having high air permeability, a mesh-like sheet or the like is used.

Additionally, in the ninth embodiment, a fuel battery is used as the power supplying means 61a. That is because the air sending means 50 sends a large amount of air and has a large power consumption, and hence using a general battery is not practical. Since a current which can be caused to instantaneously flow by the fuel battery is small as compared with a capacity thereof, a capacitor or the like having a large capacity must be also used when a large current must be caused to instantaneously flow. However, a large current does not have to be caused to instantaneously flow in the air-conditioning garment 9, and hence the fuel battery is very suitable as a power source of the air-conditioning garment 9.

In the air-conditioning garment according to the ninth embodiment, since a flow quantity of air generated by the air sending means is 60 liters/second, the air-conditioning garment according to the ninth embodiment is preferable for a use in a case where a wearer performs a heavy duty.

[10th Embodiment]

A 10th embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 25A is a schematic front view of an air-conditioning garment according to the 10th embodiment of the present invention, and FIG. 25B is a schematic rear view of the air-conditioning garment. It is to be noted that, in the 10th embodiment, like reference numerals denote parts having the same functions as those in the second embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 25, an air-conditioning garment 10 according to the 10th embodiment is provided with a clothing material portion 220, opening/closing means 31, five air circulating portions 40, 40, 40, 40c and 40c, two air sending means 50 and 50, power supplying means 61, a power supply cable 62, a power supply pocket (accommodating means) 63, an integrated belt 640, a power supply switch (not shown), and local spacers 70 and 70. This air-conditioning garment 10 is applied to a workwear in which a jacket and pants are connected as one (a jumpsuit type

garment). Here, a main specification of this air-conditioning garment 10 is organized in the table of FIG. 7.

Main differences of the air-conditioning garment 10 according to the 10th embodiment from the air-conditioning garment 2 according to the second embodiment lie in that the clothing material portion 220 covers not only an upper body but also a lower body, that an air-conditioning capability is 500 W, that the power supplying means 61 is attached on a rear side of a breast pocket, and that the integrated belt 640 which is used to attach the air sending means 50 and 50 is detachably disposed at a position corresponding to a lumbar region on an inner surface side of the clothing material portion 220. Any other points are the same as those in the second embodiment.

Characteristic points of the air-conditioning garment 10 according to the 10th embodiment will now be described in detail.

In the 10th embodiment, since the air-conditioning garment 10 is applied to a so-called jumpsuit type garment, the clothing material portion 220 covers not only the upper body but also the lower body. Therefore, a parallel-to-body airstream also flows to the lower body, and a nearly all part of a body surface excluding a part above a neck can be wrapped with the parallel-to-body airstream. In this case, as well as the upper opening portions 40, 40 and 40, the opening portions 40c and 40c in hems of leg parts serve as the air circulating portions. Further, an air-

conditioning area ratio of this air-conditioning garment 10 is approximately 80 %. It is to be noted that, in FIG. 25, each arrow indicates an outflow direction of air.

Furthermore, in order to circulate the parallel-to-body airstream to the lower body, the air-conditioning capability of the air-conditioning garment 10 is increased to 500 W. In addition to this, means which can cause the parallel-to-body airstream to flow with a flow quantity of 14 liters/second is used as each of the air sending means 50 and 50. Here, a power consumption of the two air sending means 50 and 50 is approximately 3 W. It is to be noted that means having a fan diameter of 70 mm is used as each of the air sending means 50 and 50. Furthermore, a total effective fan area of the two air sending means 50 and 50 is 62 cm^2.

The breast pocket is provided at an upper left part on outer surface side of the clothing material portion 220. In the 10th embodiment, the power supply pocket 63 is attached on an inner surface side of the clothing material portion 220 at a position corresponding to the breast pocket. Moreover, a secondary battery as the power supplying means 61 is accommodated in the power supply pocket 63. At this time, a size of the power supply pocket 63 is set to be equal to or smaller than a size of the breast pocket, and the power supply pocket 63 is stitched on the clothing material portion 220. Therefore, since a seam of the power supply pocket 63 can be covered with and

hidden by the breast pocket, there is an advantage that this seam cannot be seen from the outside. Additionally, the breast pocket usually accommodates a thing therein. Therefore, even if the power supplying means 61 is accommodated in the power supply pocket 63 provided on a rear side of the breast pocket, a wearer does not feel so uncomfortable. Further, in case of replacing the power supplying means 61, the power supplying means 61 can be readily replaced by slightly opening a fastener as the opening/closing means 31. It is to be noted that the fastener must be opened to a lower position at the time of replacement of the power supplying means 61 as an attachment position of the power supply pocket is lowered. This also applies to not only the case using the fastener but also a case using buttons or any other opening/closing means.

The integrated belt 640 will now be described. The integrated belt 640 is a band-like member which is used to attach the two air sending means 50 and 50 and the power supply cable 62. An object of this integrated belt 640 is substantially the same as that of the integrated belt used in the second embodiment. However, in the 10th embodiment, since the power supplying means 61 is accommodated in the power supply pocket 63 provided at a breast part of the closing material portion 220, it is not attached to the integrated belt 640. Furthermore, a material having low air permeability is used as a base sheet of the integrated

belt, and hence a large structural difference from the integrated belt used in the second embodiment lies in that this base sheet also functions as air guiding means. Incidentally, in case of washing the air-conditioning garment 10 according to the 10th embodiment, it is good enough to remove the integrated belt 640 and the power supplying means 61 accommodated in the power supply pocket 63 from the clothing material portion 220 and then wash the air-conditioning garment 10.

[11th embodiment]

An 11th embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 26A is a schematic front view of an air-conditioning garment according to the 11th embodiment of the present invention, and FIG. 26B is a schematic rear view of the air-conditioning garment. It is to be noted that, in the 11th embodiment, like reference numerals denote parts having the same functions as those in the second embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 26, an air-conditioning garment 11 according to the 11th embodiment is provided with a clothing material portion 230, opening/closing means 31b, lower air leak preventing means 32, three air circulating portions 40, 40 and 40, 20 air sending means 50, power supplying means 61a, a power supply cable 62, an integrated belt 64, a power supply switch (not shown), and local

spacers 70 and 70. This air-conditioning garment 11 is mainly applied to an intermediate wear which is put on under a fashionable wear having good air permeability by women (an intermediate garment). Here, a main specification of this air-conditioning garment 11 is organized in the table of FIG. 7.

Main differences of the air-conditioning garment 11 according to the 11th embodiment from the air-conditioning garment 2 according to the second embodiment lie in that the air-conditioning garment 11 is of a sleeveless type having no sleeve portions, that a Velcro tape is used as the opening/closing means 31b, that the 20 air sending means 50 are attached on the integrated belt 64, and that a fuel battery is used as the power supplying means 61a. Any other points are the same as those in the second embodiment.

Since a garment having good air permeability is put on over the air-conditioning garment 11 according to the 11th embodiment, disfigurement of the appearance of this garment must be prevented from being caused. Therefore, thin and small means is used as each air sending means 50. Specifically, it is desirable to use means having a thickness of at most 6 mm as the air sending means 50. Moreover, since an air sending quantity of the single small air sending means 50 is small, a total of 20 air sending means 50 are dispersed and attached on the integrated belt 64. Generally, it is desirable to provide at least 10 air sending means 50. Additionally, since efficiency of a

motor of the small air sending means 50 is very poor, a large power is required to obtain a desired flow quantity of a parallel-to-body airstream. The fuel battery is used as the power supplying means 61a taking this point into consideration.

Actually, in the 11th embodiment, means which can cause a parallel-to-body airstream to flow with a flow quantity of 6 liters/second is used as each of the 20 air sending means 50. A fan diameter of each air sending means 50 is 20 mm, and a total effective fan area of the 20 air sending means 50 is 45 cm^2. Here, a power consumption of the 20 air sending means 50 is approximately 8 W. Further, an air-conditioning capability of the air-conditioning garment 11 is approximately 200 W. It is to be noted that an air-conditioning area ratio of this air-conditioning garment 11 is approximately 30 %.

[12th Embodiment]

A 12th embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 27A is a schematic front view of an air-conditioning garment according to the 12th embodiment, FIG. 27B is a schematic rear view of the air-conditioning garment, and FIG. 28 is a view illustrating air sending means used in the air-conditioning garment. It is to be noted that, in the 12th embodiment, like reference numerals denote parts having the same functions as those in the seventh embodiment, thereby eliminating their detailed

explanation.

As shown in FIG. 27, an air-conditioning garment 12 according to the 12th embodiment is provided with a clothing material portion 200, opening/closing means 31a, four air circulating portions 40, 40, 40 and 40a, two air sending means 50 and 50, power supplying means 61b, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown) and a planar spacer 90. This air-conditioning garment 12 is applied to an intermediate wear which is put on between an overgarment and a body or an undergarment in a season requiring an overgarment and is intended to adjust a body temperature (a garment for temperature adjustment). Here, a main specification of this air-conditioning garment 12 is organized in the table of FIG. 7.

Main differences of the air-conditioning garment 12 according to the 12th embodiment from the air-conditioning garment 7 according to the seventh embodiment lie in that the air-conditioning garment 12 is put on under an overgarment, that a side stream fan is used as each of the air sending means 50 and 50, and the air sending means 50 and 50 are attached on an outer surface side of the clothing material portion 200, and that a primary battery is used as the power supplying means 61b. Furthermore, means which can cause a parallel-to-body airstream to flow with a flow quantity of 1.4 liters/second is used as each of the air sending means 50 and 50. A fan diameter of each

air sending means 50 is 35 mm, and a total effective fan area of the two air sending means 50 and 50 is 15 cm^2. Moreover, a power consumption of the two air sending means 50 and 50 is approximately 2 W. Moreover, an air-conditioning capability of the air-conditioning garment 12 is approximately 50 W, and an air-conditioning area ratio of the same is approximately 30 %. Any other points are the same as those in the seventh embodiment.

Characteristic points of the air-conditioning garment 12 according to the 12th embodiment will now be described in detail.

In a cold season, a lot of clothes must be put on for the sake of warmness. In case of getting on a vehicle at a run so as not to miss, e.g., a train or a bus when an overgarment is put on, high thermogenesis is temporarily involved to increase a body temperature, and liquid-like type sweat is exuded in some instances. In case of getting on a fully packed vehicle in such a state, a passenger may feel stifling and want to take off the overgarment, but he/she cannot take off his/her overgarment because of a fully loaded state, and hence he/she must bear with stifling air in some cases. The air-conditioning garment 12 according to the 12th embodiment is used in such a situation. That is, only when a wearer feels stifling, a parallel-to-body airstream is temporarily circulated between the air-conditioning garment 12 and a body or an undergarment to increase a temperature gradient in the

vicinity of a surface of the body, thereby cooling the body. Further, sweat from the body is brought into contact with the parallel-to-body airstream to vaporize sweat from the body, and an effect of drawing vaporization heat from the periphery at the time of vaporization is utilized to cool the body. It is to be noted that, in this air-conditioning garment 12 for temperature adjustment again, the air sending means 50 and 50 must generate a parallel-to-body airstream which flows with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer in order to obtain a sufficient cooling effect. Actually, it is desirable to use means which can cause the parallel-to-body airstream to flow with a flow quantity of at least 0.5 liter/second as each of the air sending means 50 and 50.

Furthermore, in the 12th embodiment, such a side stream fan as shown in FIG. 10 is used as each of the air sending means 50 and 50. Moreover, the air sending means 50 and 50 are attached on an outer side of the clothing material portion 200 as shown in FIG. 28. Therefore, a space having a gap h corresponding to a thickness of the air sending means 50 is generated between an overgarment and the clothing material portion 200. When electric power is supplied to the air sending means 50 and 50, the air sending means 50 and 50 suck air flowing in the space between the clothing material portion 200 and the body or the undergarment and discharge air in a direction substantially parallel with a surface of the clothing

material portion 200 in the space between the clothing material portion 200 and the overgarment. As a result, air which exists between the clothing material portion 200 and the body or the undergarment and has been warmed by a body temperature can be replaced with outside air. Here, in the air-conditioning garment 12 for temperature adjustment, since air flowing in the space between the clothing material portion 200 and the body or the undergarment must be discharged into the space between the clothing material portion 200 and the overgarment, a high air sending capability is required as a capability of the air sending means 50. Specifically, it is desirable to use, as the air sending means 50, means which has air sending pressure characteristics that a maximum static pressure, i.e., a pressure at a position where a flow quantity becomes zero falls within a range of 30 Pa to 300 Pa.

In the air-conditioning garment according to the 12th embodiment, a wearer can turn on the power supply switch only when he/she feels stifling, thereby cooling his/her body temperature.

[13th Embodiment]

A 13th embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 29A is a schematic front view of an air-conditioning garment according to the 13th embodiment of the present invention, FIG. 29B is a schematic rear view of the air-conditioning garment, and FIG. 29C is a view

illustrating lower air leak preventing means used in the air-conditioning garment. It is to be noted that, in the 13th embodiment, like reference numerals denote parts having the same functions as those in the first and second embodiments, thereby eliminating their detailed explanation.

As shown in FIG. 29, an air-conditioning garment 13 according to the 13th embodiment is provided with a clothing material portion 20, lower air leak preventing means 32a, three air circulating portions 40, 40 and 40, two air sending means 50 and 50, power supplying means 61, a power supply cable 62, a power supply pocket 63, a power supply switch (not shown), and local spacers 70 and 70. This air-conditioning garment 13 is applied to a daily garment having no opening/closing means on a front part like a T-shirt. Such a garment will be also referred to as a "T-shirt type garment" hereinafter. A main specification of this air-conditioning garment 13 is organized in the table of FIG. 8.

Main differences of the air-conditioning garment 13 according to the 13th embodiment from the air-conditioning garment 1 according to the first embodiment lie in that opening/closing means is not provided, that a band-like clothing material is used as the lower air leak preventing means 32a, and that the local spacers 70 and 70 are provided at parts corresponding to both shoulders of the clothing material portion 20. Further, means which can cause a parallel-to-body airstream to flow with a flow

quantity of 12 liters/second is used as each of the air sending means 50 and 50. A fan diameter of each air sending means 50 is 60 mm, and a total effective fan area of the two air sending means 50 and 50 is 45 cm^2. Furthermore, a power consumption of the two air sending means 50 and 50 is approximately 2.5 W. Moreover, an air-conditioning capability of the air-conditioning garment 12 is approximately 400 W, and an air-conditioning area ratio of the same is approximately 35 %. Any other points are the same as those in the first embodiment.

Since the opening/closing means is not provided in the air-conditioning garment 13, a wearer pulls over the air-conditioning garment 13. A T-shirt or the like which is pulled over in this manner is usually put on in a state where its hem portion is hung to the outside without being tucked into pants. Considering a wear style of such a T-shirt type garment, in the 13th embodiment, means for providing an elastic member, e.g., rubber into a band-like clothing material rather than means for providing rubber into a hem portion of the clothing material portion 20 is used as the lower air leak preventing means 32a. Specifically, the lower air leak preventing means 32a is constituted of the band-like clothing material and an elastic member. Further, as shown in FIG. 29C, the band-like clothing material is stitched on the inner surface side of the clothing material portion 20 at a position in the vicinity of the hem portion of the clothing material

portion 20 along a direction around a waist. Furthermore, the elastic member is put into an end portion of the band-like clothing material on the body side, thereby making gathering. As a result, when the air-conditioning garment 13 is put on, the end portion of the band-like clothing material in which the elastic member is provided is appressed against the body, the undergarment or a garment. Therefore, even when this air-conditioning garment 13 is put on in a state where the hem portion hangs down limply, the lower air leak preventing means 32a can prevent air from leaking from the hem portion to the outside.

[14th Embodiment]

A 14th embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 30A is a schematic front view of an air-conditioning garment according to the 14th embodiment of the present invention, FIG. 30B is a schematic rear view of the air-conditioning garment, and FIG. 31 is a schematic block diagram of a circuit portion in this air-conditioning garment. It is to be noted that, in the 14th embodiment, like reference numerals denote parts having the same functions as those in the fifth embodiment, thereby eliminating their detailed explanation.

As shown in FIGS. 30 and 31, an air-conditioning garment 14 according to the 14th embodiment is provided with a clothing material portion 200, opening/closing means 31a, four air circulating portions 40, 40, 40 and 40a, two

air sending means 50 and 50, power supplying means 61a, power supply cables 62, a power supply pocket 63, a power supply switch (not shown), a pressure-proof spacer 80, two power supply connectors 111 and 112, five sensors 121, 122, 123, 124 and 125, and a circuit portion 130. Here, a fan diameter of each air sending means 50 is 60 mm, and a total effective fan area of the two air sending means 50 and 50 is 45 cm^2. Moreover, an air-conditioning area ratio of this air-conditioning garment 14 is approximately 40 %. Various functions utilizing information processing, a communication technology and others are added to this air-conditioning garment 14. Such a garment having various functions added thereto will be also referred to as a "high-function type garment" hereinafter. A main specification of this air-conditioning garment 14 is organized in the table of FIG. 8.

Main differences of the air-conditioning garment 14 according to the 14th embodiment from the air-conditioning garment 5 according to the fifth embodiment lie in that a fuel battery is used as the power supplying means 61a and that various functions such as a function of supplying electric power to other devices, a function of automatically adjusting a flow quantity of a parallel-to-body airstream, a function as a health management garment, an Internet communicating function and others are provided. Any other points are the same as those in the fifth embodiment.

Each of the above-mentioned functions provided in the air-conditioning garment 14 according to the 14th embodiment will now be described in detail.

First, the function of supplying electric power to other devices will be described. In the 14th embodiment, a fuel battery is used as the power supplying means 61a. The plurality of power supply cables 62 which supply electric power from the power supplying means 61a to each portion are arranged on an inner surface side of the clothing material portion 200. Here, a cable having water-resisting properties is used as the power supply cable 62 to endure washing. Specifically, each power supply cable 62 connects the power supplying means 61a and respective power supply connectors 111 and 112, connects the power supplying means 61a and the circuit portion 130, and connects the circuit portion 130 and the respective air sending means 50 and 50. Electric power from the power supplying means 61a is supplied to the respective air sending means 50 and 50 through the circuit portion 130.

The power supply connector 111 is a connector used to supply electric power to a mobile phone or the like, and is attached in a breast pocket. For example, when a mobile phone is put in the breast pocket and a battery charging connector of the mobile phone is brought into contact with the power supply connector 111, a battery of the mobile phone can be charged. Additionally, the power supply connector 112 is a connector used to supply electric power

to a air-conditioning hat or an air-conditioning helmet to which the same principle as the air-conditioning garment according to the present invention is applied. When a predetermined connector provided to the air-conditioning hat or the air-conditioning helmet is connected to the power supply connector 112, electric power from the power supplying means 61a can be supplied to the air sending means provided to the air-conditioning hat or the air-conditioning helmet. Therefore, in this case, power supplying means does not have to be provided in the air-conditioning hat or the air-conditioning helmet.

The function of automatically adjusting a flow quantity of a parallel-to-body airstream which is provided in the air-conditioning garment 14 will now be described. As shown in FIG. 31, five sensors 121 to 125 are attached to the air-conditioning garment 14. That is, they are a body temperature sensor (body temperature detecting means) 121, a pulse sensor (pulse detecting means) 122, a temperature sensor 123, a humidity sensor 124, and a GPS sensor 125. The body temperature sensor 121 detects a body temperature of a wearer, and the pulse sensor 122 detects a wearer's pulse. The body temperature sensor 121 and the pulse sensor 122 are attached at predetermined positions which are in contact with a body. The temperature sensor 123 detects a temperature of outside air, and the humidity sensor 124 detects humidity of outside air. The temperature sensor 123 and the humidity sensor 124 are

attached on an outer side of the clothing material portion 200. Further, the GPS sensor 125 detects position information. Detection results obtained by these respective sensors 121 to 125 are transmitted to calculating means in the circuit portion 130. It is to be noted that the body temperature sensor 121 and the pulse sensor 122 will be generically referred to as a "physical condition sensor (physical condition detecting means)", and the temperature sensor 123 and the humidity sensor 124 will be generically referred to as an "environment sensor" hereinafter.

Furthermore, as shown in FIG. 31, the circuit portion 130 is provided with an input interface 131, storing means 132, calculating means 133, fan controlling means (drive controlling means) 134, communicating means 135 and an output interface 136.

As the input interface 131, there is, e.g., an input terminal for a keyboard. As a result, for example, a wearer can connect a keyboard to the input terminal and use this keyboard to input various kinds of information before putting on the air-conditioning garment 14. Personal information of a wearer is stored in the storing means 132. As the personal information, there are, e.g., a height, a weight, a body temperature/pulse when well-conditioned, a blood group, a physical condition of the day and others. A wearer can input such information by using the keyboard. It is to be noted that various kinds of information such as

a wearer's address, a phone number and others as well as the above-described information can be stored in the storing means 132.

The communicating means 135 transmits/receives data concerning a physical condition or the like detected by the various sensors 121 to 125 to/from external receiving means. Furthermore, as the output interface 136, there is, e.g., an audio output terminal for a speaker. As a result, a wearer can hear sounds or the like from a speaker.

The calculating means 133 estimates a sweating quantity required for a human body to perform appropriate heat radiation in accordance with the situation at the time based on detection results obtained by the physical condition sensor and the environment sensor, and calculates a flow quantity of a parallel-to-body airstream required to vaporize all of the sweating quantity. A calculation result obtained by the calculating means 133 is transmitted to the fan controlling means 134. Moreover, the calculating means 133 also functions as controlling means for controlling respective portions.

The fan controlling means 134 determines drive conditions of the air sending means 50 and 50 based on the flow quantity of the parallel-to-body airstream calculated by the calculating means 133, and controls driving of the air sending means 50 and 50 in accordance with the determined drive conditions. Here, as the drive conditions of the air sending means 50 and 50, e.g., the number of

revolutions of a motor is used. That is because, when the number of revolutions of the motor is determined, a flow quantity of the parallel-to-body airstream is also determined. Specifically, the fan controlling means 134 controls the number of revolutions of the air sending means 50 by changing a voltage which is supplied to the air sending means 50. In this case, it is desirable to provide a DC-DC converter (DC-DC converting means) capable of changing an output voltage between the power supplying means 61a and the air sending means 50 and 50. And, the fan controlling means 134 controls the DC-DC converter to change a quantity of power supplied to the air sending means 50 and 50, thereby controlling a flow quantity of air generated from the air sending means 50 and 50. There is an advantage that the number of revolutions of the air sending means 50 can be controlled by using the DC-DC converter without involving a loss of power very much. As described above, in the air-conditioning garment 14 according to the 14th embodiment, an appropriate quantity of air can be automatically allowed to flow into the clothing material portion 200 in accordance with a physical condition of a wearer or a temperature/humidity of outside air. It is to be noted that, e.g., one which subjects an output voltage to PWM modulation and then rectifies the PWM-modulated voltage by using a capacitor may be utilized as the DC-DC converter.

It is to be noted that, in the 14th embodiment, means

which can cause a parallel-to-body airstream to flow with a flow quantity of up to 47 liters/second is used as each of the air sending means 50 and 50. When the parallel-to-body airstream is caused to flow with this maximum flow quantity, a power consumption of the two air sending means 50 and 50 is 40W. Additionally, an air-conditioning capability of the air-conditioning garment 14 is 1500 W at the maximum level.

According to characteristics of the parallel-to-body airstream, even if the parallel-to-body airstream is caused to flow with a flow quantity larger than a flow quantity required for vaporizing sweat, the physiological cooler is not affected. However, when a flow quantity of the parallel-to-body airstream is always fixed, the air-conditioning capability is fixedly determined. Therefore, even if a quantity of heat radiation which is physiologically required by a body is small, a power consumption of the air sending means 50 and 50 is fixed. As a result, a time in which the air sending means 50 and 50 can be driven with one refueling operation to the power supplying means 61a is reduced. This point is the same in a case where a secondary battery is used as the power supplying means. In the air-conditioning garment 14 according to the 14th embodiment, a flow quantity of a parallel-to-body airstream can be automatically controlled in accordance with a quantity of heat radiation which is physiologically required by the body at the time.

Therefore, not only wasteful use of a fuel (or a battery) can be suppressed, but also a lifetime of the air sending means 50 and 50 can be prolonged.

Further, in general, ambient noise is small in an environment where a light duty such as an office work is performed, but ambient noise is large in an environment where a heavy labor is carried out. In the air-conditioning garment 14 according to the 14th embodiment, since a flow quantity of the parallel-to-body airstream is automatically controlled in accordance with a quantity of heat radiation which is physiologically required by the body, the number of revolutions of the air sending means 50 and 50 is reduced and noise generated from the air sending means 50 and 50 is decreased in case of putting on the air-conditioning garment 14 in a quiet environment such as an office. Therefore, a wearer himself/herself and people around him/her do not feel that noise of the air-conditioning garment 14 is disturbing. On the other hand, in case of putting on the air-conditioning garment 14 in an environment where a heavy labor is performed, the number of revolutions of the air sending means 50 and 50 is increased, and the noise generated from the air sending means 50 and 50 also becomes large. However, the ambient noise is also large, and hence the noise of the air-conditioning garment 14 does not become a serious problem.

It is to be noted that a sweating quantity required for the body to perform appropriate heat radiation in

accordance with a situation at the time cannot be accurately estimated by just using detection results from the physical condition sensor and the environment sensor in some cases. That is because there is an individual difference in a quantity of heat radiation physiologically required by the body in accordance with a situation of work. In such a case, it is desirable for the calculating means 133 to estimate a sweating quantity by using personal information of a wearer such as a weight, a physical condition of the day and others stored in the storing means 132 in addition to detection results from the physical condition sensor and the environment sensor. As a result, the calculating means 133 can accurately and meticulously determine a sweating quantity required for the body to perform appropriate heat radiation in accordance with a situation at the time.

A description will now be given as to a function as a health management garment provided in the air-conditioning garment 14. In order to realize this function, the calculating means 133 further performs the following processing. That is, the calculating means 133 judges whether a body temperature or a pulse falls within a predetermined reference range based on the body temperature/pulse detected by the physical condition sensor. When it is determined that the body temperature or the pulse is out of the reference range, a predetermined warning is generated from a speaker connected to the output

interface 136. As a result, a wearer can immediately know that a problem has occurred in his/her body temperature or pulse. Here, information about the reference range of the body temperature and the pulse is stored in the storing means 132 in advance.

Furthermore, when the calculating means 133 judges whether each of a body temperature and a pulse falls within a predetermined reference range based on the body temperature/pulse detected by the physical condition sensor and determines that, e.g., the pulse exceeds a predetermined abnormal value, the calculating means 133 generates information concerning a physical condition based on detection results obtained by the physical condition sensor and transmits the information concerning the physical condition to the communicating means 135. This abnormal value is stored in the storing means 132 in advance. Further, the communicating means 135 transmits the information concerning the physical condition to external receiving means. Here, the receiving means is installed in, e.g., a wearer's family hospital. Furthermore, the "information concerning the physical condition" includes not only the body temperature/pulse (the physical condition) detected by the physical sensor but also position information detected by the GPS sensor 125 and personal information of a wearer stored in the storing means 132. In particular, since the position information detected by the GPS sensor 125 is included in

the "predetermined information", a person responsible in a hospital where the receiving means is installed can specify a place where a wearer is based on this position information. Therefore, when a wearer is involved in a physical emergency situation, an ambulance or the like can be rapidly informed of a place of the wearer (a patient).

It is to be noted that various sensors such as a sensor which checks a state of a heart can be used besides the body temperature sensor 121, the pulse sensor 122 as the physical condition sensor. When various physical condition sensors are added to the air-conditioning garment 14, the function as the health management garment provided in the air-conditioning garment 14 can be further improved.

The Internet communicating function provided in the air-conditioning garment 14 will now be described. A function of connecting to the Internet to perform communication is added to the communicating means 135. Furthermore, when a wearer utilizes the Internet communicating function, inputting means such as a keyboard is connected to the input interface 131, and outputting means for outputting information downloaded through the Internet is connected to the output interface 136. For example, desired music can be downloaded through the Internet by operating the keyboard, and this music can be output from the speaker. Here, in place of attaching the speaker to the air-conditioning garment 14, a headphone may be connected to a headphone audio output terminal of the

output interface 136 so that a wearer can listen to the music from the headphone. Moreover, when a video output terminal is provided to the output interface 136 and a spectacles type visual display device is connected to this video output terminal, a wearer can put on this spectacles type visual display device to view a downloaded picture. Incidentally, it is desirable to provide a terminal for a voice input device to the input interface 131 and perform voice input through the voice input device in place of the keyboard. As a result, a wearer can readily perform an input operation, and hence the Internet communicating function of the air-conditioning garment 14 can be further exploited.

In the air-conditioning garment according to the 14th embodiment, the calculating means calculates a quantity of heat radiation which is physiologically required by a human body at the time based on a physical condition of a wearer and a temperature/humidity of outside air, and a flow quantity of a parallel-to-body airstream can be automatically controlled in accordance with the quantity of heat radiation. Therefore, when this air-conditioning garment is put on, a wearer can obtain a cooling effect appropriate for himself/herself irrespective of a body type of the wearer or contents of work.

It is to be noted that the description has been given as to the case where the body temperature sensor and the pulse sensor are used as the physical condition sensor in

the 14th embodiment, but the body temperature sensor alone may be used as the physical condition sensor.

Additionally, the description has been given as to the case where a sweating quantity is estimated based on detection results obtained by the physical condition sensor and the environment sensor to determine a flow quantity of a parallel-to-body airstream in the 14th embodiment. However, when the physical condition sensor is used, the physical condition sensor must be attached at a position which is in contact with a body, and this attachment is slightly troublesome. Therefore, a work volume sensor (work volume detecting means) such as an acceleration sensor which detects an approximate value of a work volume in accordance with movements of a body may be used in place of the physical condition sensor. This work volume sensor does not have to be necessarily attached at a position which is in contact with the body, and it may be attached at any position of the air-conditioning garment. In this case, the calculating means estimates a sweating quantity required for a human body to perform appropriate heat radiation in accordance with a situation at the time based on detection results obtained by the work volume sensor and the environment sensor.

Further, the air-conditioning garment according to the 14th embodiment has a sufficient utility value when it is provided with the function as the health management garment or the Internet communicating function even if the

function of cooling down a body is not provided.

[15th Embodiment]

A 15th embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 32A is a schematic front view of an air-conditioning garment according to the 15th embodiment of the present invention, FIG. 32B is a schematic rear view of the air-conditioning garment, FIG. 33A is a schematic front view of air sending means used in the air-conditioning garment, and FIG. 33B is a schematic side view of the air sending means. Furthermore, FIG. 34A is a view illustrating a state where the air-conditioning garment is put on, and FIG. 34B is a view illustrating a state of a belt portion when the air-conditioning garment is put on. It is to be noted that, in the 15th embodiment, like reference numerals denote parts having the same functions as those in the fifth embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 32, an air-conditioning garment 15 according to the 15th embodiment is provided with a clothing material portion 200, opening/closing means 31a, four air circulating portions 40, 40, 40 and 40a, two air sending means 550 and 550, a pressure-proof spacers 80 and 800 and a remote control transmitter (remote control transmitting means) 140. This air-conditioning garment 15 is obtained by improving the air-conditioning garment 5 for office use according to the fifth embodiment. This air-

conditioning garment 15 will be also referred to as an "improved air-conditioning garment for office use" hereinafter. A main specification of this air-conditioning garment 15 is organized in the table of FIG. 8.

Main differences of the air-conditioning garment 15 according to the 15th embodiment from the air-conditioning garment 5 according to the fifth embodiment lie in that revolution control of the respective air sending means 550 and 550 is performed by the remote control transmitter 140 and that the pressure-proof spacer 800 is provided at a position on an inner surface side of the clothing material portion 200 corresponding to a lumbar region. Any other points are the same as those in the fifth embodiment.

Characteristic points of the air-conditioning garment 15 according to the 15th embodiment will now be described in detail.

In the 15th embodiment, a so-called hybrid fan is used as the air sending means 550. A basic structure of this air sending means 550 is substantially the same as that of the air sending means 50 shown in FIGS. 10 and 11, but the air sending means 550 is different from the air sending means 50 in that it is provided with power supplying means 551, a receiving circuit (receiving means) 552 and a control circuit (controlling means) 553 as shown in FIG. 33 in addition to respective constituent elements of the air sending means 50. Here, a tabular mounting portion 555 is provided to an internal fan guard of the air

sending means 550, and the power supplying means 551, the receiving circuit 552 and the control circuit 553 are disposed on the mounting portion 555.

The power supplying means 551 supplies electric power to the air sending means 550. Here, a capacitor is used as the power supplying means 551. The capacitor is very suitable to be used as a power source for the air-conditioning garment because its duration of life is very long, it can be charged in a short time and safety is high, for example. The receiving circuit 552 receives a signal from the remote control transmitter 140. The control circuit 553 controls driving of the air sending means 550 based on a signal received by the receiving circuit 552. Furthermore, the remote control transmitter 140 functions as flow quantity adjusting means for adjusting a flow quantity of air generated by the air sending means 550 and 550. Specifically, the remote control transmitter 140 transmits a signal which instructs to turn on/off the air sending means 550 and 550 and a signal which instructs to adjust an air sending quantity to a predetermined quantity.

Since the power supplying means 551 is disposed to the air sending means 550 itself in this manner, the power supplying means 551 does not have to be connected to the air sending means 550 through a power supply cable, and there is also an advantage that removing the air sending means 550 and 550 can suffice when washing the air-conditioning garment 15. Moreover, a wearer can operate

the remote control transmitter 140 to readily adjust a flow quantity of air generated by the air sending means 550 and 550.

In the air-conditioning garment 15 according to the 15th embodiment, the pressure-proof spacer 800 is attached at a position corresponding to a lumbar region on the inner surface side of the clothing material portion 200. Specifically, the pressure-proof spacer 800 is attached at a position of the clothing material portion 200 corresponding to at least a belt portion of pants when a hem portion of the clothing material portion 200 is tucked into the pants. A configuration of this pressure-proof spacer 800 is substantially the same as that of the pressure-proof spacer 80 attached at a back part of the clothing material portion 200.

When this pressure-proof spacer 800 is provided, as shown in FIG. 34, even if the hem portion of the clothing material portion 200 is tucked into the pants and the belt of the pants is fastened, the hem portion of the clothing material portion 200 is not appressed against a body or an undergarment. Therefore, a part of a parallel-to-body airstream generated by the air sending means 550 and 550 is also sent to a lower body through the pressure-proof spacer 800. Therefore, when a material from which air rarely leaks is used as a clothing material of the pants, the pants can function as air guiding means, and an opening portion at each hem portion of the pants can serve as an

air circulating portion. In this case, a parallel-to-body airstream can be caused to flow in not only the air-conditioning garment 15 but also the pants. Therefore, an air-conditioning area ratio can be greatly improved. For example, when a wearer puts on the pants as the air guiding means together with the air-conditioning garment 15, the air-conditioning area ratio is improved to approximately 80 %.

It is to be noted that the pressure-proof spacer 800 does not have to be necessarily attached at the hem portion of the clothing material portion 200. As described above, the pressure-proof spacer 800 functions to prevent the hem portion of the clothing material portion 200 from being appressed against the body or the undergarment when a belt or the like of the pants is fastened on the body, and to assure an air circulating space to the lower body. Therefore, as an attachment method of the pressure-proof spacer 800, any method can be used as long as it is a method by which the pressure-proof spacer 800 can exist between the clothing material portion 200 and the body or the undergarment. That is, it is good enough for the pressure-proof spacer 800 to be provided at a position corresponding to at least the belt portion of the pants when the hem portion of the clothing material portion 200 is tucked in the pants (a garment for a lower body). For example, the pressure-proof spacer 800 may be attached on an outer surface of a stomach band. In this case, a wearer

puts on the air-conditioning garment 15 after wearing the stomach band. As a result, an air circulating space can be assured between the clothing material portion 200 and the stomach band.

In the air-conditioning garment according to the 15th embodiment, since a wearer can use the remote control transmitter to adjust a flow quantity of a parallel-to-body airstream, the wearer can obtain a cooling effect suitable for himself/herself irrespective of a body type of the wearer or contents of work.

[16th Embodiment]

A 16th embodiment according to the present invention will now be described with reference to the accompanying drawings. FIG. 35A is a schematic front view of an air-conditioning garment according to the 16th embodiment of the present invention, FIG. 35B is a schematic rear view of the air-conditioning garment, FIG. 36A is a schematic plan view when an air-conditioning belt used in the air-conditioning garment is seen from a rear surface side, FIG. 36B is a view illustrating a state where the air-conditioning belt is fastened, and FIG. 37 is a schematic side view of air sending means used in the air-conditioning garment. It is to be noted that, in the 16th embodiment, like reference numerals denote parts having the same functions as those in the first embodiment, thereby eliminating their detailed explanation.

As shown in FIG. 35, an air-conditioning garment 16

according to the 16th embodiment is provided with an upper clothing material portion 260 which covers an upper part of an upper body, a lower clothing material portion 270 which covers a lower part of the upper body, two opening/closing means 31 and 31, two attaching/detaching means 34 and 34, three air circulating portions 40, 40 and 40, and an air-conditioning belt 150. Although the air-conditioning garment is produced while exploiting a general clothing conformation in the first to 15th embodiments, the clothing material portion is divided into upper and lower portions by using the air-conditioning belt 150 in the 16th embodiment. The air-conditioning garment 16 according to the 16th embodiment will be also referred to as an "air-conditioning belt type garment" hereinafter. A main specification of this air-conditioning garment 16 is organized in the table of FIG. 8.

The upper clothing material portion 260 covers the body above an umbilical region, and the lower clothing material portion 270 covers a lumbar region. The upper clothing material portion 260 and the lower clothing material portion 270 function as air guiding means. Therefore, a material from which air rarely leaks is used as a material of the upper clothing material portion 260 and the lower clothing material portion 270. Furthermore, fasteners as the opening/closing means 31 and 31 are respectively provided at a front part of the upper clothing material portion 260 and a front part of the lower clothing

material portion 270.

A lower end of the upper clothing material portion 260 is detachably disposed to an upper end of the air-conditioning belt 150 by the attaching/detaching means 34, and an upper end of the lower clothing material portion 270 is detachably disposed to a lower end of the air-conditioning belt 150 by the attaching/detaching means 34. Here, fasteners are used as the attaching/detaching means 34 and 34. Therefore, when the upper clothing material portion 260 and the lower clothing material portion 270 are attached to the air-conditioning belt 150, the air-conditioning garment 16 is brought to completion.

As shown in FIG. 36, the air-conditioning belt 150 is provided with a belt-like base member (a band-like member) 151, two air sending means 560 and 560, fan controlling means 152, power supplying means 61, a power supply switch (not shown), flow quantity adjusting means (not shown), a plurality of pressure-proof spacers 153, and Velcro tapes 154a and 154b. Electrical components such as air sending means 560 and 560, fan controlling means 152, power supplying means 61 and others are attached on a rear surface of the base member 151.

The two air sending means 560 and 560 are attached at predetermined positions on the base member 151. The air sending means 560 is a so-called propeller fan, and has a motor (not shown), a propeller 561, direction converting means 562 and a fan guard 563 as shown in FIG. 37. The fan

guard 563 accommodates the motor, the propeller 561 and the direction converting means 562. The propeller 561 takes in outside air from a rotation axis direction of the propeller 561, and supplies air in substantially parallel with the rotation axis direction on an opposite side of the intake side. The direction converting means 562 converts a flow direction of air in such a manner that air taken in along the rotation axis direction from the propeller 561 flows radially toward a direction substantially orthogonal to the rotation axis direction. For example, a member having a substantially conical shape can be used as the direction converting means 562. Therefore, the air sending means 560 and 560 can take in outside air, and allow the taken air to flow in a direction substantially parallel with a surface of a body. It is to be noted that using gap holding means for providing a gap between a lower end of the propeller 561 and the body or an undergarment directly brings air taken in from the propeller 561 into contact with the body or the undergarment. As a result, a flow direction of air can be converted. However, this gap holding means can be regarded as one of direction converting means. Moreover, as a method of attaching the air sending means 560 to the air-conditioning belt 150, the same method as that described in the first embodiment can be used.

Additionally, as each of the air sending means 560 and 560, means which can cause a parallel-to-body airstream to flow with a flow quantity of 12 liters/second is used.

A fan diameter of each air sending means 560 is 60 mm, and a total effective fan area of the two air sending means 560 and 560 is 45 cm^2. Here, a power consumption of the two air sending means 560 and 560 is approximately 2.5 W.

The power supplying means 61 supplies electric power to the fan controlling means 152 and the air sending means 560 and 560. The fan controlling means 152 controls a flow quantity of air generated by the air sending means 560 and 560. Additionally, the non-illustrated flow quantity adjusting means adjusts a flow quantity of air generated by the air sending means 560 and 560. As the flow quantity adjusting means, a volume is used, for example.

Each pressure-proof spacer 153 is disposed between respective electrical components such as air sending means 560 and 560, fan controlling means 152, power supplying means 61 and others. The pressure-proof spacer 153 assures a space which allows circulation of air between the air-conditioning belt 150 and the body, and its structure is the same as that of the pressure-proof spacer 80 shown in FIG. 19.

The Velcro tape 154a is attached at one end portion of the base member 151 on its rear surface in a longitudinal direction thereof, and the Velcro tape 154b is attached at the other end portion of base member 151 on its front surface in the longitudinal direction. Here, assuming that the Velcro tape 154a is for a surface A, the Velcro tape for a surface B which is attached on the former

tape is the Velcro tape 154b. Therefore, when the air-conditioning belt 150 is put around a waist, attaching the Velcro tape 154a and the Velcro tape 154b on each other can prevent the air-conditioning belt 150 from falling from the waist. That is, the Velcro tapes 154a and 154b are belt holding means for adjusting a length of the air-conditioning belt 150 and attaching the air-conditioning belt 150 around the waist. It is to be noted that the plurality of pressure-proof spacers 153 are attached on the base member 151, and hence a space can be assured between the air-conditioning belt 150 and the body even if the air-conditioning belt 150 is fastened tightly.

In case of putting on the air-conditioning garment 16 according to the 16th embodiment, the upper clothing material portion 260 and the lower clothing material portion 270 are first attached to the air-conditioning belt 150. Then, a wearer puts arms through sleeve parts of the upper clothing material portion 260. Additionally, the front part of the upper clothing material portion 260 is closed by doing up the fastener of the upper clothing material portion 260, and the front part of the lower clothing material portion 270 is closed by doing up the fastener of the lower clothing material portion 270. At last, both ends of the air-conditioning belt 150 are attached by using the Velcro tapes 154a and 154b. In this manner, the air-conditioning garment 16 is put on. It is to be noted that a hem portion of the lower clothing

material portion 270 is tucked in pants or the like in order to prevent air from leaking to the outside from the hem portion of the lower clothing material portion 270 in this example.

When a wearer presses the power supply switch (not shown) provided to the air-conditioning belt 150, the fan controlling means 152 supplies electric power to the air sending means 560 and 560, and the air sending means 560 and 560 are driven. As a result, a parallel-to-body airstream is generated from the air-conditioning belt 150, and the generated parallel-to-body airstream flows through a space between the upper and lower clothing material portions 260 and 270 and the body and is discharged to the outside from the air circulating portions 40, 40 and 40. It is to be noted that an air-conditioning capability of the air-conditioning garment 16 is approximately 400 W.

It is to be noted that, as the upper clothing material portion and the lower clothing material portion, one having any shape can be used as long as it has a shape which can cause the parallel-to-body airstream to flow between the upper and lower clothing material portions and the body or the undergarment. Further, a method of holding the air-conditioning belt is not restricted to the Velcro tapes, and various methods such as a regular belt buckle can be used. Furthermore, opening/closing means for opening/closing the front part of each of the upper clothing material portion and the lower clothing material

portion is not restricted to the fastener, and any method can be used as long as it is a method which can assuredly perform coupling with less air leak.

It is to be noted that the present invention is not restricted to the foregoing embodiments, and various modifications can be carried out within the scope of the invention.

The description has been given as to the air-conditioning garments for various intended purposes in each of the first to 16th embodiments. Of course, the air-conditioning garment according to the present invention is not restricted to these air-conditioning garments, and it may be obtained by rationally combining the specifications of the foregoing embodiments.

Moreover, in each of the foregoing embodiments, flow path setting means for forcibly setting a path through which air flows in a space between air guiding means and a body or an undergarment may be provided on an inner surface of the air guiding means. For example, a member having a light weight such as a sponge can be used as the flow path setting means. When this flow path setting means is provided, performance of the air-conditioning garment can be further improved.

Additionally, in each of the above-described embodiments, air agitating means for forcibly disturbing a flow of air in the space between the air guiding means and the body or the undergarment may be provided at some

positions on an inner surface of the air guiding means. For example, a member having a light weight such as a sponge can be used as the air agitating means. When this air agitating means is provided, a parallel-to-body airstream can be prevented from becoming a laminar air flow. When the parallel-to-body airstream becomes a laminar air flow, air in the parallel-to-body airstream which is apart from the body, i.e., which flows on the air guiding means side does not contribute to vaporization of sweat very much.

Further, when the intake mode is adopted as an air sending mode of the air sending means and a parallel-to-body airstream has a large flow quantity and a high wind pressure, it is undesirable to use means having a shape which causes it to be greatly distanced from the body as the air guiding means. When the air guiding means having such a shape is used, since air flows as a laminar air flow in the vicinity of the air guiding means in a space between the air guiding means and the body or the undergarment, wasteful air which does not contribute to vaporization of sweat much is increased. However, even if the air guiding means is greatly distanced from the body or the undergarment in the vicinity of the air sending means originally having a large air sending quantity, this distanced part functions as one type of an air reservoir, and an air resistance when taking air into the air-conditioning garment from the outside is reduced. Therefore, in such a case, when the air guiding means is

greatly distanced from the body or the undergarment, a air sending quantity is increased, thereby improving the air-conditioning efficiency as the entire air-conditioning garment.

Furthermore, as described above, the air-conditioning capability of the air-conditioning garment depends on a vaporization contributing ratio of air. Moreover, the vaporization contributing ratio of air varies depending on a shape of the clothing material portion, presence/absence of the air agitating means and others. Considering this point, in order to actually realize the air-conditioning capability shown in each of corresponding FIGS. 5 to 8 in the air-conditioning garment according to each of the foregoing embodiments, air having a flow quantity which falls within a range which is approximately 80 % to approximately 150 % of a flow quantity of air shown in these drawings must be allowed to flow in the space between the clothing material portion and the body or the undergarment.

A description will now be given as to a relationship between a flow quantity of air generated in a space between the clothing material portion and the body or the undergarment and a total effective cross-sectional area of the air circulating portions, and a relationship between a total effective cross-sectional area (a total effective fan area) of the air sending means and a total effective cross-sectional area of the air circulating portions.

FIG. 38 is a view schematically showing an air flow path reaching the air circulating portions from the air sending means through the space between the air guiding means and the body or the undergarment (an air circulating space). Here, a consideration will be given as to a case where outside air flows into the air circulating space from the air sending means and flows to the outside from air outflow portions. Additionally, the path shown in FIG. 38 represents a path through which air actually flows when a wearer turns on a switch of the air sending means. In FIG. 38, reference character S1 denotes a total effective fan area, reference character S2 denotes a total effective cross-sectional area of the air circulating space at a given position in the air circulating space, and reference character S3 denotes a total effective cross-sectional area of the air circulating portions. When, e.g., a propeller fan is used as the air sending means, the total effective fan area S1 is obtained by summing up areas of propeller portions of the respective air sending means, and an area of a central part of the air sending means where no propeller is constituted is not included in the total effective fan area S1. Further, the total effective cross-sectional area S3 of the air circulating portions is an area obtained by projecting an area of each air circulating portion on a flat surface vertical to a flow direction of air transmitted through the air circulating portion. Here, the air circulating portion which is formed by using such a

cloth having high air permeability as described in the fifth embodiment is also added to calculation of the total effective cross-sectional area S3 of the air circulating portions.

In general, as shown in FIG. 38, the total effective cross-sectional area S2 of the air circulating space is increased as distanced from the air sending means, and it is reduced as getting closer to the air circulating portion. Furthermore, the total effective cross-sectional area S3 of the air circulating portions is usually larger than the total effective fan area S1. That is, there is a relationship of $S1 < S3 < S2$ between the three total effective cross-sectional areas S1, S2 and S3 except a region close to the air sending means and the air circulating portion.

Since the total effective fan area S1 is substantially equal to an area of the air sending means which is seemingly exposed, it is not preferable to greatly increase the total effective fan area S1 in order to reduce an uncomfortable feeling about the appearance of the air-conditioning garment. Moreover, if the total effective cross-sectional area S3 of the air circulating portions is increased, many air circulating portions must be provided to the air guiding means. However, when this configuration is adopted, an average distance by which a parallel-to-body airstream flows in the air circulating space is reduced, thereby lowering a vaporization contributing ratio of air.

Based on a result of confirmation by the present inventor through an experiment, when the air circulating portions are provided to the air guiding means, in order to prevent the vaporization contributing ratio of air from greatly lowering, assuming that a flow quantity of air generated in the space between the air guiding means and the body or the undergarment is L liters/second, it is good enough to set the total effective cross-sectional area of the air circulating portions to $20 \cdot L^{1/2}$ cm^2 or below. Here, a constant "20" is a quantity having a dimension, and a product of this constant and $L^{1/2}$ has a dimension of an area.

When a flow quantity of air is small, e.g., when it is 6 liters/second or below, the total effective fan area S1 is small as shown in a section of the total effective fan area in each of FIGS. 5 to 8. Actually, the relationship of S1 < S3 < S2 is achieved except a region close to the air sending means and the air circulating portion. Therefore, in this case, the uncomfortable feeling about the appearance of the air-conditioning garment is small, and the total effective cross-sectional area S3 of the air circulating portions does not have to be increased. Thus, the vaporization contributing ratio of air is not lowered.

On the other hand, if a flow quantity of air is tried to be increased, the total effective fan area S1 must be increased. In this case, the relationship between the three total effective cross-sectional areas S1, S2 and S3

is not achieved in some cases unless the total effective cross-sectional area S3 of the air circulating portions is increased. If the total effective cross-sectional area S3 of the air circulating portions is considerably smaller than the total effective fan area S1, an air sending pressure must be greatly increased, which results in an inconvenience, e.g., a significant increase in power consumption. Considering this point, even if the total effective cross-sectional area S3 of the air circulating portions is smaller than the total effective fan area S1, the total effective cross-sectional area S3 of the air circulating portions must be at least 0.7-fold of the total effective fan area S1. Furthermore, according to a confirmation by the present inventor based on an experiment, it is good enough to set the total effective cross-sectional area S3 of the air circulating portions to $5 \cdot L^{1/2}$ cm^2 or above in order to avoid such an inconvenience. Here, a constant "5" is a quantity having a dimension, and a product of this constant and $L^{1/2}$ has a dimension of an area.

Therefore, in the air-conditioning garment, assuming that a flow quantity of air generated in the space between the air guiding means and the body or the undergarment is L liters/second, it is desirable that the total effective cross-sectional area of the air circulating portions falls within a range of $5 \cdot L^{1/2}$ cm^2 to $20 \cdot L^{1/2}$ cm^2. Moreover, it is desirable that a ratio of the total effective cross-sectional area of the air circulating portions with respect

to the fan total effective area (the total effective cross-sectional area of the air sending means) is at least 0.7-fold.

In the air-conditioning garment according to the present invention, considering energy saving, continuous service hours of a battery (an available time provided by single charging in case of a secondary battery) and a cost or a weight of a battery, a larger ratio of the air-conditioning capability of the air-conditioning garment with respect to a power consumption of the air sending means is good. In particular, when outside air has a temperature of 33 °C and humidity of 50 % and a flow quantity of air generated in the space between the air guiding means and the body or the undergarment is at least 5 liters/second, it is desirable for a ratio of the air-conditioning capability of the air-conditioning garment with respect to a power consumption of the air sending means to be at least 50-fold. It is to be noted that this ratio is dependent on efficiency of the motor of the air sending means, a vaporization contributing ratio of air and others.

Further, in the air-conditioning garment according to the present invention, assuming that a flow quantity of air generated in the space between the air guiding means and the body or the undergarment is L liters/second, it is practical to use, as the air sending means, means which having such air sending pressure characteristics as a

maximum static pressure, i.e., a pressure at a position where a flow quantity becomes zero falls within a range of $5 \cdot L^{1/2}$ pascals to $50 \cdot L^{1/2}$ pascals. Here, constants "5" and "50" are quantities each having a dimension, and a product of each of these constants and $L^{1/2}$ has a dimension of a pressure. In order to realize this, when a flow quantity of air flowing through the space between the air guiding means and the body or the undergarment is not greater than 10 liters/second, it is desirable to use a propeller fan as the air sending means. When a flow quantity of air is greater than 10 liters/second, it is desirable to use a turbo fan as the air sending means.

Air permeability of the air guiding means will now be described. As explained in the first embodiment, when an air sending mode of the air sending means is an intake mode and a flow quantity of air generated by the air sending means is large, the air guiding means in the vicinity of the air sending means expands due to a pressure difference between an external pressure and a pressure in the air guiding means, and a so-called "air reservoir" is formed in the vicinity of the air guiding means. Moreover, a flow quantity of air leaking from the air guiding means becomes largest at a part where this "air reservoir" is formed (an air reservoir portion). Here, the pressure difference at this air reservoir portion can be reduced in accordance with a design of the air-conditioning garment, e.g., increasing a total effective cross-sectional area of the

air circulating portions. Additionally, in order to reduce a power consumption and noise of the air sending means to decrease a burden on the air sending means, the pressure difference at this air reservoir portion must be reduced. As a result of an experiment conducted by the present inventor, assuming that a flow quantity of air flowing through the space between the air guiding means and the body or the undergarment is L liters/second, it was confirmed that the burden imposed on the air sending means can be reduced if the pressure difference at the air reservoir portion is approximately $0.5 \cdot L$ pascals. Here, a constant "0.5" is a quantity having a dimension, and a product of this constant and L has a dimension of a pressure. Considering both this value and an area of the air guiding means forming the air reservoir portion, when a pressure is applied to the air guiding means and the pressure difference at this air reservoir portion is 10 pascals, a problem of air leak can be avoided if a flow quantity of air leaking per cm^2 in one second is not greater than 5 cc. Incidentally, it can be considered that the pressure difference is substantially proportional to a flow quantity of leak air in this pressure region. When a flow quantity of air caused to flow in the air-conditioning garment is 10 liters/second which is a typical value and an area of the air guiding means forming the air reservoir portion is 300 cm^2, a pressure difference at the air reservoir portion is 5 pascals, and hence a flow quantity

of air leaking in the air reservoir portion is 5·(5/10)·300 = 750 cc/s. That is, air of 750 cc leaks from the air reservoir portion in one second. At this time, a ratio of a flow quantity of air leaking in the air reservoir portion with respect to a flow quantity of air which is 10 liters/second is 7.5 %. It is to be noted that the same concept applies to the case where the air sending mode of the air sending means is a discharge mode.

Additionally, in the second, eight and 11th embodiments, the description has been given as to the case where the integrated belt mode is adopted as an attachment/detachment mode of the air sending means and the power supplying means is arranged on the integrated belt. However, the power supplying means does not have to be necessarily arranged on the integrated belt depending on an intended use of the air-conditioning garment, and the power supplying means may be attached to, e.g., a belt of pants. It is to be noted that this point can be likewise applied to other air-conditioning garments as well as the air-conditioning garment adopting the integrated belt mode, and the power supplying means may be attached at any position.

Further, in case of using the air-conditioning garment according to the present invention, it is desirable to prepare many clothing material portions excluding electrical components and prepare only one set of the electrical component. When this electrical component is attached to the clothing material portion which is actually

put on, it is possible to enjoy air-conditioning garments having different colors, patterns, shapes and others everyday.

INDUSTRIAL APPLICABILITY

As described above, in the air-conditioning garment according to the present invention, means which can generate air flowing with a flow quantity of at least 0.01 liter/second per kg of a weight of a wearer is used as the air sending means. Therefore, the air-conditioning garment according to the present invention can rapidly vaporize sweat generated from a body, and expand a range in which a physiological cooler function originally included in a human body is effectively exercised. Therefore, it can be applied to, e.g., a garment for a light duty, a garment for a medium duty, a garment for work in the rain, a garment for a line operation, a garment for office use, a garment for outdoor, a garment for deodorization, a garment for children, a garment for a heavy duty and others.